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Waste Management Strategies for Los Alamos National Laboratory – 1997

Background Information for the Site-Wide Environmental Impact Statement

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PREFACE

In October 1994, the Los Alamos National Laboratory (LANL) established a Project Office to support the Department of Energy (DOE) in preparing a site-wide environmental impact statement (SWEIS). The role of the Project Office was not to prepare the SWEIS but rather to respond to DOE's requests for information.

One of the tasks that DOE assigned to the Project Office was development of options or strategies that could be used to manage solid and liquid wastes generated by LANL's operations. LANL's Waste Management Program Office prepared the options or strategies, and the SWEIS Project Office provided oversight in accordance with direction provided by DOE.

The preparers developed a range of strategies for managing (i.e., treating, storing, and disposing of) wastes and DOE directed the selection of three possible strategies for detailed evaluation to bound the range of possible strategies. These strategies are presented in this report as the Current Path, Maximum Onsite, and Minimum Onsite waste management strategies. These three strategies were evaluated for each of the four SWEIS alternatives and for each of five waste types.

Finally, the use of LANL as a regional treatment and disposal center for DOE wastes was examined qualitatively. In its Waste Management Programmatic Environmental Impact Statement, the DOE determined that LANL could be chosen as the site for treating and/or disposing of some wastes from Rocky Flats, Kansas City, Pantex, Grand Junction, and Sandia. Because Records of Decision for each of the waste types had not been prepared at the time this strategies document was finalized and because details about implementation of such decisions were not available, it was not possible to evaluate this concept in detail at the time this strategies document was prepared.

This document, which was completed in February 1997, uses the waste projections for the SWEIS available at that time. As the SWEIS continued to be developed, minor changes were made in specific waste projections to reflect new information. As a result, the estimates in this document are not always exactly the same as those in the SWEIS. The differences were examined and were not considered substantive enough to affect strategy analysis. DOE used this document as background information for a discussion of waste management in the SWEIS.

ACKNOWLEDGMENTS

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1. INTRODUCTION

This report provides background and technical information related to various strategies that Los Alamos National Laboratory (LANL) would use to manage solid and aqueous waste streams from the Site-Wide Environmental Impact Statement (SWEIS) alternative scenarios. It is organized to provide easy reference on the technologies and techniques that could be used to effectively manage all types of waste generated from LANL operations and cleanup.

The general process followed to develop the information in this report is discussed below. A more detailed summary of the process is presented in Chapter 2.

1.1 Strategy Development Process

The process followed to develop the waste strategies presented in this report involved the following steps:

- Select waste types to be considered.
- Identify waste streams within each waste type.
- Identify waste management options to be considered.
- Identify waste management options to be employed.
- Compare the range of strategies from Maximum Onsite to Minimum Onsite.
- Identify how the Current Path Strategy compares to the Maximum and Minimum Onsite strategies.

1.1.1. Select Waste Types To Be Considered

For this study, the following waste types were selected:

- Low-level waste (LLW).
- Mixed low-level waste (MLLW).
- Chemical waste.
- Radioactive liquid waste (RLW).
- Transuranic (TRU)/mixed transuranic (MTRU) waste.

1.1.2. Identify Waste Streams Within Each Waste Type

For each waste type, the overall waste volume was categorized in treatability groups according to the type of treatment and/or disposal that was appropriate/possible. In general, this fractioning was accomplished by reviewing historical waste records and making adjustments for SWEIS assumptions and other considerations.

1.1.3. Identify Waste Management Options To Be Considered

For this step, the project team developed a conceptual model of waste treatment, storage, and disposal options that could be applied to one or more waste Treatability groups. Each of these options was researched, evaluated, and described at a generic level before any waste Treatability group evaluations were begun. In several cases, unit processes were judged inappropriate for consideration at LANL. For example, those with schedules that exceeded the 10-year SWEIS period of interest were excluded.

1.1.4. Identify Waste Management Options To Be Employed

In this step, the project team selected the specific unit processes that would be appropriate and effective for each waste type and Treatability group. This was an iterative process and involved considerable revisions for nearly all waste types. For this report, the LANL Current Path option was developed to be consistent with general waste management planning and performance objectives for the future, including those volume reduction and disposal options that will help make LANL a "Best of Class" operation. Best of Class includes environmental protection, limited program vulnerability, and overall cost-effectiveness to programmatic clients.

1.1.5. Compare the Range of Strategies From Maximum Onsite to Minimum Onsite

Using the Current Path strategy as a framework, the team then evaluated how this scenario compared to a maximum onsite program as well as a minimal onsite presence. Using the Current Path as a starting point, the team developed a flowsheet to describe how increased waste management capabilities would change the overall Waste Management system. This strategy is presented as the Maximum Onsite Strategy, and in some cases approaches a regional waste treatment capability. Finally, the team developed the minimum configuration that would allow waste to be prepared for management offsite, unless this option was precluded for technical or regulatory reasons. This strategy is presented as the Minimum Onsite Strategy, and is intended to identify the minimal level of onsite effort that is required to manage waste according to current regulation. Both the Maximum and Minimum Onsite strategies are intended to bound the range of activity that could be accomplished, and do not reflect LANL Waste Management Program objectives in the same way the Current Path Strategy does.

1.1.6 Identify How the Current Path Strategy Compares to the Maximum and Minimum Onsite Strategies

As a final step, all three strategies were compared for each waste type. Where a Maximum or Minimum Onsite strategy was inappropriate, the team documented the underlying rationale for this conclusion. In some cases, the Maximum or Minimum Onsite strategies were technically identical to the Current Path, and this was noted in the narrative discussion for that waste type.

1.2. General Assumptions

The following assumptions were incorporated in the strategy development process:

- All waste volumes reflect the 10-year SWEIS horizon.
- Regulatory structures and constraints will remain consistent through the 10-year SWEIS period.
- The Current Path strategy is similar to current operational plans, but is not entirely consistent with these plans because of waste volume and SWEIS planning assumptions.

1.3. Report Organization

Chapter 2 of this report provides a detailed summary of the process followed to complete the system study and prepare this report. Chapter 3 presents information on LLW management. Chapter 4 provides information about transuranic (TRU) waste and how it would be managed at LANL. Chapter 5 offers similar information on MLLW, with Chapter 6 describing chemical waste management at LANL. Chapter 7 provides additional information about how the U.S. Department of Energy (DOE) Waste Management Programmatic Environmental Impact Statement (WM PEIS) would alter the LANL Expanded alternative, with special emphasis on waste management capability needs associated with the additional waste volumes to be managed from other DOE facilities.

2. THE STRATEGY DEVELOPMENT PROCESS

The process followed to develop the LANL waste management strategies involved the following steps:

1. **Develop "bottom up" projections by facility** -- The first step in developing the waste management strategies required that waste management projections be developed to reflect the SWEIS alternatives. In this step, the project team interviewed LANL facility staff to estimate the overall quantity of waste that would be generated over the 10-year period of interest.

2. **Identify all waste management options that may be useful** -- This step included a comprehensive effort to gather and assimilate a wide range of descriptive information about each unit process or technique that might be used as part of a waste management strategy. In some cases, this included information about offsite vendors, facilities, and technologies that had not been widely considered for LANL waste, but which may be useful in the future.

3. **Develop waste treatability groups (waste streams)** -- For this activity, the project team developed a group of waste streams so that the waste projection could be identified according to available treatment, storage, or disposal options. For some waste types, the treatability groups were based primarily on the disposal options; however, for waste streams regulated by the U.S. Environmental Protection Agency (EPA)/New Mexico Environment Department (NMED) the breakdown was consistent with the treatment/destruction options mandated by regulation.

4. **Screen options that are beneficial for one or more waste streams --** In this step, the range of management options was evaluated to screen out items that were not appropriate for LANL, or which could not be developed in the 10-year time frame because of development constraints.

5. **Develop a matrix of options for the Current Path, Maximum Onsite, Minimum Onsite strategies --** In this activity, the project team identified the appropriate options for each strategy for each waste type. In selecting these configurations, the team developed 15 distinct strategies to reflect the waste management system that could manage all of LANL's waste appropriately. With considerable discussion, several strategies were revised based on input from Waste Management and SWEIS personnel.

6. **Estimate volume reduction factors for beneficial processes --** For this step, the volume adjustments associated with each conversion process were estimated, based on DOE or commercial experience. Where several treatability groups were judged to have distinct volume reduction ratios, these ratios were estimated separately to develop an overall volume reduction/increase for the conversion process.

7. **Perform material balance for all waste for each strategy --** Using the initial waste projection information and the volume reduction factors from previous steps, the team completed a material balance to determine the quantity of waste to be disposed under each strategy. With the exception of chemical waste (for which waste quantities were estimated by mass), this balance was accomplished using waste volumes.

8. **Evaluate the DOE WM PEIS as a special case to the LANL Expanded alternative --** As a final technical activity, the team reviewed the waste management assumptions provided in the draft Waste Management PEIS and created four additional flowsheets to demonstrate how offsite waste volumes would influence LANL waste management needs in the future. In nearly all cases, the PEIS technical information about waste to be managed by LANL under regional alternatives was very limited, and the analysis should be considered preliminary unless further effort to refine it is completed.

9. **Prepare a technical summary report --** As a final step, the team organized the technical information into this technical report.

3. LOW-LEVEL WASTE MANAGEMENT STRATEGY

This chapter discusses the general characteristics of LLW generated at LANL and four elements of its management: characterization, treatment, storage, and disposal. Three strategies for managing LANL's LLW over the next 10 years—Current Path, Maximum Onsite, and Minimum Onsite—are postulated and evaluated.

3.1. LLW Definitions and Description

LLW is waste that contains radioactivity and is not classified as high-level waste, TRU waste, spent nuclear fuel, or tailings from the milling of uranium or thorium ore. LLW may include test specimens of fissionable material irradiated for research and development purposes, provided that the material's concentration of transuranic isotopes is less than 100 nCi/g. Fissionable material generated during the production of power or plutonium does not qualify as LLW.

LLW is generated by LANL facilities involved in research and production activities relating to nuclear weapons technology, nuclear materials processing, high explosives testing and fabrication, accelerator technology, radioisotope production, radiochemistry, nuclear medicine, metallurgy, and materials science. LLW is also generated from environmental restoration (ER) projects, decontamination and decommissioning (D&D) activities, and waste management operations.

To facilitate its proper handling, treatment, and disposal, LLW is categorized according to its physical, chemical, and radiological characteristics. The types or forms of LLW generated at LANL (as distinguished by waste code and waste description) include plastics, cellulosics, combustible lab trash, glass, nitrate salts, evaporator bottoms, scrap metal, and molecular sieves. All told, approximately 60 to 70 waste types of LLW are generated at LANL. In this chapter, these wastes are consolidated into "Treatability groups" based on similarities in waste characteristics and common disposition. These Treatability groups are listed in Table 3-1.

3.2. LLW Inventories

Projections of LLW generated at LANL have been developed in support of DOE's site-wide EIS process. These projections provide 10-year waste volume estimates for the different levels of operations considered under the four SWEIS alternatives: No Action, Expanded, Reduced, and Greener. The waste projections include contributions from 13 key LANL facilities, other non key facilities, waste management facilities, and environmental restoration projects. The projections do not account for waste generated by the Capability Maintenance Improvement Project (CMIP), nor that produced from the upgrade of the Chemistry and Metallurgy Research (CMR) facility. The waste projections and their development are described in detail in the SWEIS Waste Projections Data Package (Rogers & Associates Engineering Corporation 1996). The projected LLW volumes for the four SWEIS Alternatives are summarized in Table 3-1.

The development of the LLW Treatability group volumes listed in Table 3-1 involved (1) applying facility-specific historical distributions to the total projected LLW volumes for each key facility and each other generator entity, and (2) summing over all the generators to arrive at the LANL total volumes. Facility-specific details that influence the Treatability group distributions were also considered and appropriate adjustments made. The LLW Treatability group volumes served as the starting point for developing the waste management strategies.

3.3. LLW Management Elements

LLW management at LANL is driven by federal and state regulatory requirements, DOE policies and guidance (in particular, DOE Order 5820.2A, “Radioactive Waste Management,” DOE 1988), funding levels, available cost-effective technologies, storage and disposal capacities, and projected waste generation volumes. Existing management of LLW is implemented through the CST Waste Management Facilities Waste Acceptance Criteria and Certification (LANL 1994) and through other administrative and detailed operating procedures in place at waste generating and management facilities.

Development of LANL’s waste management strategy alternatives considered the following elements:

- Characterization.
- Treatment.
- Storage.
- Disposal.

Since the ultimate disposition of LLW is disposal, most of the precursor strategy elements are implemented to ensure that LLW is managed consistent with DOE and worker exposure requirements. The following sections describe these strategy elements and identify technologies and techniques that are available to manage LLW.

3.3.1. Characterization

Waste characterization involves (1) identifying and quantifying radioactive constituents present in the waste, and verifying that the waste does not contain regulated chemicals or (2) either has characteristics or listed chemicals that would make the waste subject to hazardous waste regulations or that the waste does not contain regulated chemicals. Waste characterization techniques that are currently implemented at LANL include (a) acceptable knowledge (AK), and (b) sampling and analysis. These characterization techniques are described in the following paragraphs.

3.3.1.1. Acceptable Knowledge

AK refers to information that is used for waste characterization in place of direct waste sampling and analysis. It includes process knowledge and previous chemical/analytical results associated with the waste. The AK technique involves documenting the raw materials used in a process or operation, the associated material safety data sheets, the products produced, and the waste generated. It also requires knowing the facility or process history and all previous and current activities that affect the facility or processes that generate the waste. Once a generator documents and certifies the pedigree of the waste stream using AK, the chemical composition, radionuclide content, and physical form of the waste are often well understood. Waste generators use the AK technique to characterize LLW in situations where the same types of waste are continuously generated and where the level of radioactive contamination is typically low. The AK technique is also helpful in instances where the direct measurement techniques are relatively insensitive, such as for low-energy beta-gamma emitting species, or when internal shielding makes measurements inaccurate. For some radionuclides (e.g., Pu and U), material accountability records are maintained to ensure fissionable material is tracked. These records are significantly more precise and accurate than would otherwise be available through direct measurement.

3.3.1.2. Sampling and Analysis

This characterization technique provides the most direct and usually most accurate waste characterization information, provided it is performed correctly and on representative waste samples. Proper sampling and analysis techniques can be ensured by using a sampling and analysis plan that documents the analytical techniques employed, sample handling procedures, and quality assurance and quality control considerations. Sampling and analysis techniques employed for LLW characterization may either be direct radiological assays or indirect radiological measurement. The former technique relies on analytical measurements using gamma spectroscopy, passive and/or active neutron scanning, liquid scintillation counting, gross alpha/beta counting, and alpha spectroscopy. The latter technique relies on (a) use of scaling factors, where the activity of one radionuclide is inferred from the measured activity of another radionuclide; (b) gross radiation measurements, where exposure rates measured in units of mR/hr are converted into estimated activities for certain gamma emitting radionuclides using published gamma factors; or (c) calculations, where contamination levels are theoretically derived.

Although characterization is an important element of waste management, it does not directly contribute to the evaluation of LLW management strategies (at least not in the context of the SWEIS). However, it may play a significant role in waste minimization because accurate characterization techniques may prevent suspect wastes from being included as LLW, hence reducing the overall volume of materials that must be managed as LLW. No credit has been taken for waste minimization as a means to reduce the volume of LLW that needs to be managed in the next 10 years.

3.3.2. Treatment

Treatment of LLW may be necessary to meet the waste acceptance criteria implemented at the LLW disposal facility. In general, waste acceptance criteria are implemented to ensure that the disposal site can meet regulatory mandates to protect the environment and the safety and health of workers and the public. Treatment may also be necessary to reduce the volume of waste actually shipped or disposed of, to meet Department of Transportation (DOT) regulations for transportation, to reduce disposal costs, or to preserve the capacity of the disposal facility. Depending on the circumstances, waste treatment can be conducted by waste generators or performed as a centralized effort.

General waste treatment techniques used to reduce the as-disposed volume of LLW or produce more stable waste forms include:

- Sorting and segregation.
- Supercompaction.
- Decontamination.
- Size reduction.
- Incineration.
- Solidification and absorption.
- Polymer encapsulation.

Each of these treatment techniques and its applicability to the management of LANL's LLW over the next 10 years is discussed in the paragraphs that follow.

3.3.2.1. Sorting and Segregation

Sorting and segregation refer to the physical separation of LLW according to its waste form, such as metal, wood, glass, or paper. Sorting and segregation is performed to direct waste to its appropriate treatment schemes (e.g., separation of combustible wastes from noncombustible wastes or collection of metallic materials for decontamination). This technique is used at nuclear power plants to ensure cost-effective treatment and disposal of generated LLW. It also is used at incineration facilities to facilitate optimal burn efficiency in feed streams.

Sorting and segregation are a labor-intensive operation that requires workers to manually separate waste items on a sorting table. In some limited instances, the process may be automated (e.g., separating ferrous metals with a magnet). However, because the technique often requires that workers manually handle the LLW, personnel safety and the potential for radiation exposure must be given the proper attention.

Although LANL has not implemented a centralized sorting and segregation process for LLW, LANL-generated waste shipped to the onsite disposal facility at Technical Area 54 (TA-54), Area G, is tracked in the waste management database system by individual containers and individual waste items. Physical characteristics of the waste are included on the waste manifest and maintained in the electronic database. In effect, this process is equivalent to sorting and segregation by the waste generators. Presently, this tracking process meets LANL's needs because the LLW is disposed of with very limited treatment. In the future, LANL may wish to implement a more formal LLW sorting and segregation program so that it may use additional LLW treatment schemes. It is reasonable to expect that LANL generators could segregate the wastes by collecting them in separate containers as they are generated, thus eliminating the need to sort combined wastes. The process could be implemented by the same process used for recycling at LANL, where waste generators place paper, aluminum, and cardboard in separate and distinctly labeled collection bins.

3.3.2.2. Supercompaction

Supercompaction yields higher volume reduction ratios than those achieved by other volume reduction techniques, such as conventional compaction, bailing, and shredding. Supercompaction employs a powerful hydraulic piston to crush waste materials and decrease void space. While a conventional low-force compactor can provide about a 2 to 1 volume reduction, the supercompactor can achieve volume reductions as high as 8 to 1.

The supercompacted waste form, due to reduced void space, provides inherent waste package integrity and minimizes the potential for subsidence at the disposal site. A potential drawback of supercompaction is that the radionuclide concentrations in the final waste form are inversely proportional to the waste volume. Thus, while the volume of waste may decrease by a factor of 8, concentrations of radioactivity in the compacted waste will increase by that same factor. This can change transportation and disposal requirements for some types of waste.

In 1996, LANL completed the construction of a 200-ton-box supercompactor for the treatment of compactible LLW generated at LANL. The supercompactor is housed on a concrete pad in a dome at Area G. Because of the uncertainty in the exact makeup of compactible wastes expected to be generated at LANL, for this document, a conservative volume reduction factor of 4 to 1 was assumed to be achieved by the LANL supercompactor.

3.3.2.3. Decontamination

Decontamination of solid waste articles with removable contamination has been demonstrated for a wide range of materials and removal techniques. Decontamination can be accomplished using chemical surfactants and physical abrasion techniques that involve high pressure streams of water, sand blasting, and dry ice blasting. Decontamination is generally considered when contamination is removable and the articles to be cleaned are bulky and difficult to dispose of, expensive, or could be reusable or recyclable. Waste streams that are candidates for decontamination include stainless steel components, piping and hardware. For some streams, decontamination can be used to change the waste type designation (e.g., from TRU waste to LLW.)

Decontamination is a labor intensive process. While the limiting factor for other techniques may be the equipment required to employ them, the limiting factor for decontamination often is the experience of equipment operators and their understanding of the waste articles requiring decontamination. Decontamination may be carried out in any area where ventilation and spill control can be ensured. Because decontamination is generally a manual operation, it may subject workers to increased risks of radiation exposure.

The benefits derived from decontamination hinge on the waste stream under consideration. For example, many items in a particular waste stream may not be readily decontaminated or may be of little value, thus negating any benefits from the process. Although it sometimes produces secondary wastes, decontamination allows recovery of high value items and generally is most applicable to metallic wastes. It is anticipated that decontamination would reduce the as-disposed volume of LANL's projected scrap metal LLW by about 10 percent based on historical experience for a wide range of waste articles. Presently, LANL does not have a dedicated LLW decontamination program in place.

3.3.2.4. Size Reduction

Size reduction of discrete articles can be used to minimize the bulk volume of waste. This technique is effective for bulk items that cannot be compacted, such as stainless steel gloveboxes and other bulky enclosures. In some cases, it allows portions of the waste item that are not contaminated to be released for conventional recycling or disposal as industrial waste.

The LANL Waste Characterization, Reduction, and Repackaging Facility (WCRRF) uses plasma arc torches and other metal cutting apparatus to reduce the size of metal wastes and other materials. The WCRRF is not designed for operations requiring significant shielding from high radiation exposure (such as a hot cell might provide), but does have ventilation control and is designed to contain alpha emitters. Size reduction processes similar to those carried out at the WCRRF have been used at other DOE facilities to reduce volumes of high activity wastes. It is anticipated that applying size reduction techniques (through the WCRRF) to the scrap metal component of LLW generated at LANL would reduce the volume of that waste by 50 percent. This value is slightly more conservative than historical volume reduction rates, which are closer to 4:1.

3.3.2.5. Incineration

Incineration is a thermal treatment process that subjects waste to high temperature combustion, which produces stable ash, water vapor, and carbon dioxide under controlled conditions. Incineration is widely used to destroy toxic organic compounds in hazardous waste. Incineration also is used to stabilize inorganic compounds by converting them into oxides in the form of ash or slag. For LLW, incineration can be used to achieve volume reduction ratios as high as 400 to 1 for cellulosic wastes (such as paper, wood, rags, and lab coats). Volume reduction ratios for metallic waste, salts, concrete rubble, and soils are lower than those achievable for cellulosic wastes. The effective volume reduction ratio for LANL's combustible LLW materials is judged to be about 100 to 1.

Although incineration may be a highly effective treatment process in terms of volume reduction, it also is expensive. An incineration facility must incorporate the sophisticated energy control and off gas treatment systems required for efficient and safe operation. Because of the high initial investment required for its development, incineration is commonly pursued as a regional or national service. Commercial incineration facilities for the treatment of LLW are currently available and used by many industrial and medical LLW generators. However, the cost of incinerating waste relative to the cost of direct disposal or treatment by other means (such as compaction) must be considered in selecting the most cost effective waste management strategy. Transportation costs and risks associated with delivering waste to and retrieving ash from an incineration facility must also be considered when evaluating the viability of incineration.

While no capability for onsite incineration is currently available at LANL, a controlled air incinerator (CAI) was operational at LANL through fiscal year 1996. The system was designed and constructed to demonstrate how controlled air incineration could convert LANL generated radioactive and chemical wastes to more stable waste forms with consequent waste volume reductions. However, due to difficulties in permitting the system and changes in DOE policy, the CAI was dismantled in 1996. The time required to plan, site, design, build, test, and permit an incinerator may exceed 10 years. Therefore, for all practical purposes, an onsite incineration system at LANL is not a viable treatment option. However, LANL may be able to ship its LLW to an offsite incineration facility.

Several alternative thermal treatment technologies and systems are being developed by the DOE and private industry. These systems are similar to incineration in that the final products are stabilized ash and inert off gases. The various thermal treatment systems differ in the method used to achieve the required high temperature and oxidation conditions. The systems currently being developed are generally geared toward treating problematic MLLW containing both radioactive and hazardous constituents. The hazardous components must be removed or destroyed for the waste to be properly disposed of as LLW.

3.3.2.6. Solidification and Absorption

The waste acceptance criteria (WAC) of Area G require that only stable solid waste forms be accepted for disposal. Therefore, radioactively contaminated liquid wastes, sludges, or waste packages containing residual free liquids must be treated prior to disposal. Two general processes for eliminating the free liquids in the LLW are solidification and absorption.

Solidification is a process that converts liquid or sludge to a solid waste form. Many types of solidification techniques are available, but the most common is cementation or solidification by the addition of Portland cement to the liquid waste or sludge. Although solidification processes exist for non-aqueous liquids, cementation is generally applied only to aqueous liquids because the water in the waste is itself a necessary reagent in the cementation reaction. The proportions of the aqueous waste, the amount of Portland cement or other cementing agent, and reagents are adjusted to yield a stable, cured waste form. The final waste form from cementation is usually a solid block of cement or solid cement rubble.

For LLW containing residual free liquids or for radioactively contaminated oils and solvents [not regulated by the Resource Conservation and Recovery Act (RCRA)], absorption is the most commonly used technique to remove the liquid. Absorption involves using an absorbent material such as vermiculite to soak up the liquid waste, hence eliminating any free liquids. Depending on the type of liquid, other absorbent media may be used in place of vermiculite.

Currently, solidification by cementation and absorption is employed at LANL to solidify small volume liquid waste streams prior to disposal at Area G. Large volumes of radioactive liquid waste streams are piped to and treated at TA-50-1, the Radioactive Liquid Waste Treatment Facility. Waste generators are responsible for producing the final solidified or absorbed waste form for disposal. Therefore, in the evaluation of the LANL LLW management strategies, the final solidified/absorbed waste form was considered to be the as-generated waste form.

3.3.2.7. Polymer Encapsulation

Polymer encapsulation is a relatively new waste treatment process that stabilizes reactive waste materials or liquid waste streams by mixing them with thermoplastic or thermosetting compounds. The DOE currently is developing two primary polymer encapsulation processes: micro encapsulation and macro encapsulation.

In the micro encapsulation process, thermoplastic polymers such as polyethylene are combined with dried waste in a commercially available extruder. This process melts the polymer and mixes it with the waste. The encapsulated waste then is extruded into a drum, where it solidifies upon cooling. The micro encapsulation process operates at low temperatures, requires no off gas treatment, and generates no secondary waste.

In the macro encapsulation process, bulk materials such as metallic waste and debris are placed in a drum and encapsulated with molten or liquid plastic compounds. When cured, the final waste form is an inert polymeric matrix that not only is interspersed throughout the waste, but which completely surrounds the waste. Hence, the encapsulated waste is precluded from reacting with its environment. Although macro-encapsulation may also be applied for liquid waste streams, its application is restrictive because of interferences of the liquids with the reacting plastic compounds.

Currently, macro encapsulation is being used at LANL to stabilize uranium chips and turnings (U chips). All previously stored U chips immersed in diesel fuel have been encapsulated using a sulfur based rubber matrix. Newly generated U chips will also be stabilized using the same process. DOE has mandated that the waste generator be responsible for stabilizing U chips in the future; however, depending on the number of waste generators and the cost of obtaining and operating encapsulation systems, it may be argued that centralized onsite stabilization of the U chips is a reasonable alternative.

3.3.3. Storage

Storage of LLW has not been necessary or desirable in the past because disposal capacity has been available within Area G. Current practice at Area G involves placing waste into disposal pits or shafts as soon as it is received. Temporary storage would only be pursued in the event that disposal capacity were unavailable in the future.

While storage has been necessary for wastes that are sent off site for treatment, the need to move the waste several times and the risk posed to waste workers makes this option unattractive, expensive, and inconsistent with as low as reasonably achievable (ALARA) objectives. If it becomes necessary for LANL to temporarily store LLW, the waste most likely will be stored in tension support domes (which have been repeatedly used for various waste management activities). For this document, it was assumed that disposal capacity will be commensurate with incoming waste volumes.

3.3.4. Disposal

The ultimate disposition of LLW is near-surface disposal. As mentioned, LLW generated at LANL is disposed of at Area G in pits and shafts. Disposal options considered to be viable in the next 10 years include:

- Area G Existing Footprint - Constructed Pits.
- Area G Existing Footprint - New Pits.
- Area G Existing Footprint - Shafts.
- Area G Expansion - Zone 4.

- Area G Expansion - Zone 5 SW.
- Offsite DOE Facilities - Nevada Test Site (NTS)/Hanford Site (Hanford).
- Offsite Commercial Facility - Envirocare of Utah.

Siting and constructing a new disposal facility at LANL have also been considered. While this option is technically practical, it is not substantively different from development of Zones 4 or 5. Because this option would be duplicative of other options that were considered, it is not addressed in the report.

The following paragraphs discuss each of the seven disposal options under consideration. To facilitate the discussions of LANL's disposal facility, a map of Area G and adjacent areas is shown in Figure 3-1.

3.3.4.1. Area G Existing Footprint - Constructed Pits

The Area G facility, situated on Mesita del Buey Road at the east end of TA-54, has been the main disposal site for LANL's solid radioactive waste since 1957. It is the only currently active LLW disposal facility at LANL. Area G encompasses nearly 40 pits, 4 trenches, approximately 200 shafts, and 7 surface pads containing solid radioactive waste. The legacy inventory buried at Area G includes TRU waste disposed of prior to 1971 and MLLW disposed of before July 25, 1990, the effective date of regulation of mixed waste by the State of New Mexico. Currently, pits 15, 31, 37, 38, and 39 have been constructed and are in use for the disposal of solid LLW. The remaining disposal capacity in these pits totals about 26,000 m^3.

The types of LLW that are disposed of in pits include:

- Low activity waste (< 200 mrem/hr).
- Tritiated waste (<20 mCi/m^3).
- Radioactive asbestos.
- Powders/ash/particulates (stabilized).

Guidelines for constructing disposal units at LANL were established in conjunction with the U.S. Geological Survey. Typically, pits cover approximately 7,500 m^2 each and are approximately 20 m deep. The original design specification required that pits be oriented along the central axis of Mesita del Buey and then proceed toward the edges. Pits are excavated at least 15 m from the edge of the mesa and as far as possible from surface drainages on the mesa. The bottoms of the pits are at least 3 m above the floor of adjacent canyons. The corners of each pit are identified with markers. Topsoil and tuff removed during excavation are reserved for future use. Following excavation, crushed tuff is placed on the floors of the pits and used to seal fractures in the pit floors. Each layer of LLW is covered with a layer of clean tuff ranging from 15 to 30 cm thick. When a pit is nearly full, the uppermost meter of the pit is filled with a thick layer of crushed tuff, mounded over with topsoil, and then revegetated. Approximately 20 to 25 percent of the pit volume is filled with LLW, and the remainder is either void space or tuff/soil fill.

To increase disposal pit efficiency and preserve space, LANL is currently pursuing new requirements and procedures for LLW disposal. New procedures are being developed that will require waste generators to leave no more than a 10 percent void space in all waste packages. A second change will mandate the use of specific waste packaging, thereby improving waste stacking and placement efficiency. Area G waste operating procedures are also being revised to increase package placement efficiencies, resulting in a dense array package placement for pit disposal. Another change will allow the use of slightly contaminated bulk solids and rubble as fill material between layers of waste with higher levels of contamination. Because package and placement voids will be lower, the quantity of backfill needed can be reduced as a further efficiency benefit. The procedures being developed are intended to allow the amount of LLW in each pit to be increased to approximately 50 percent of the total pit volume. This gain would be in addition to any generator void space reduction or compaction efficiency gains prior to waste emplacement. However, the implementation of such a practice will have to be evaluated on the basis of performance assessment results.

3.3.4.2. Area G Existing Footprint - Shafts

Shafts are used at Area G for the disposal of special-category wastes or waste that requires special handling. Open shafts, monofill shafts, and lined shafts are used to dispose of the following types of LLW:

- High activity waste (>200 mR/hr) - open shafts.
- Tritiated waste (>20 mCi/m^3 <100 Ci/m^3) - open shafts.
- Powders/ash/particulates (stabilized) - open shafts.
- Radioactive asbestos waste - monofill shafts.
- Radioactive biological waste - monofill shafts.
- Beryllium waste - monofill shafts.
- Small polychlorinated-biphenyl- (PCB-) contaminated items - monofill shafts.
- Tritiated waste (> 100 Ci/m^3) - lined shafts.

Shafts are drilled up to 20 m into the tuff and range from 0.3 to 2.5 m in diameter. Shafts used for high activity tritiated waste are lined with a corrugated metal culvert. The top meter of the shaft is reserved for a 1 m thick concrete plug. Any void remaining between the top of the waste and the concrete plug is filled with excavated, clean tuff. Because of their small surface area, the shafts can be scattered throughout the existing Area G footprint. Since the projected volume of LLW that requires disposal in shafts is quite small, it is expected that the shaft capacity in the existing Area G footprint will be adequate for the next 10 years.

3.3.4.3. Area G Existing Footprint - New Pits

In addition to the already constructed pits and efforts to increase the disposal efficiency of those pits, innovative ideas for expanding the pit disposal capacity within the existing Area G footprint are being evaluated. While some of the innovations are trivial, others require additional engineering studies. The options being considered for expanding the pit capacity at Area G include:

- Excavate Pit 23.
- Cut new pits over unused shaft fields.
- Reuse any empty TRU waste storage pits.
- Develop the drainage basin area.

Excavation of Pit 23 will add approximately 5,600 m^3 of waste disposal capacity. However, the area designated for Pit 23 may have surface contamination, which would reduce the size of the pit, or even preclude excavation.

Cutting new pits over unused shaft fields could be used to provide additional pit disposal capacity in areas that have been used historically for shaft disposal. If the developed shaft capacity has not been used, the land could be converted to pit disposal. At the present time, the potential disposal capacity associated with this technique has not been estimated because this option would present a number of technical challenges and potential difficulties.

Another approach to maximize the use of the existing Area G footprint centers on the use of shallow disposal pits that could become available should legacy TRU waste be retrieved and placed in above grade interim inspectable/retrievable storage. Reuse of such TRU pits could be expected to provide an additional 3,500 m^3 of LLW disposal capacity; however, this option has not been pursued because several technical and logistical challenges related to it must be resolved. The potential for soil contamination or radiation exposure is uncertain and might make this option unattractive or impractical. Another uncertainty relates to the logistical problem of using the pit capacity before all TRU waste is retrieved.

One area of the existing Area G footprint that has not been developed, but which could be used for shallow pit disposal, is the drainage basin area, as shown in Figure 3-1. The area is a sloping drainage on the southern portion of the active disposal area. This area could be developed as a series of "contour" pits, or the entire area could be used as an irregularly shaped disposal cell. It is anticipated that slightly sloped area can be easily developed (Phase I Slope Area), but the steeper portions would require additional engineering consideration (Phase II Slope Area). The potential disposal capacity of this area is being investigated, but no estimate is available at this time.

Given the early stage of development of additional pits within the existing Area G footprint, the technical challenges that must be overcome, and the uncertainties associated with implementing any of the above options, only 10,000 m^3 of additional disposal capacity is assumed for the new pits option. While additional capacity may be developed within this "footprint", the cost for development would be significantly higher than historical activities.

3.3.4.4. Area G Expansion - Zone 4

Expansion of Area G into adjacent lands would yield significantly higher disposal capacities than attempts to expand disposal capacity within Area G's own footprint. One such area that is available for expansion is Zone 4, which encompasses the land west of the active disposal area, east of the existing ER exclusion area, and north of the Mesita del Buey access road (see Figure 3-1). Approximately 8 acres of land are available for development. Of that, about 1 acre on the east of the parcel may be excluded due to ER exclusion zones and footings required for a proposed transmission line. An additional 3 acres may also become available on the west side of the parcel if an area designated as an ER exclusion area is either remediated or determined to not require remediation. Thus, the potential expansion area ranges from 7 to 11 acres. Zone 4 expansion would yield approximately 60,000 to 80,000 m^3 of additional LLW disposal capacity.

3.3.4.5. Area G Expansion - Zone 5 SW

Another area available for Area G expansion lies west of the active disposal area, east of the existing ER exclusion area, and south of the Mesita del Buey access road (see Figure 3-1). This area is referred to as Zone 5 SW and covers about 17 acres. It is estimated that this area would yield about 150,000 to 200,000 m^3 of additional LLW disposal capacity.

3.3.4.6. Offsite DOE Facilities - NTS/Hanford

Besides LANL's onsite disposal facility, DOE also owns and operates several other disposal facilities in support of the nation's nuclear program. Two of these facilities - the Nevada Test Site (NTS) and Hanford Site - are considered to be reasonable alternatives for disposing of LANL's LLW, should the disposal capacity at Area G be exceeded in the next 10 years. The waste acceptance criteria at NTS and Hanford are similar to those implemented at LANL.

NTS and Hanford currently accept LLW from other DOE facilities for permanent disposal. The disposal capacity at each of the facilities is expected to greatly exceed the volume of LLW projected to be generated by LANL in the next 10 years. Potential drawbacks to using these two facilities are disposal costs and transportation costs and risks.

3.3.4.7. Offsite Commercial Facility - Envirocare of Utah

As a contingency option for preserving disposal space at Area G, LANL developed an exemption package seeking DOE approval to ship ER soil and decommissioning debris to Envirocare of Utah for disposal. Envirocare is licensed by the State of Utah and can accept the following types of waste:

- Waste containing naturally occurring radioactive materials.
- Waste with radioactivity < 2000 pCi/g Ra 226 equivalent.
- Waste with radioactive concentrations within the guidelines stipulated in Envirocare's license agreement.

It is anticipated that Envirocare will be able to accept low activity soils and debris resulting from LANL's ER projects.

3.4. LLW SWEIS Strategies

Three LLW management strategies were postulated based on viable characterization, treatment, storage, and disposal (CTSD) capabilities. These strategies are:

- Current Path.
- Maximum Onsite.
- Minimum Onsite.

Section 3.4.1 presents the viable CTSD capabilities and describes how they would be implemented in the three LLW management strategies. Sections 3.4.2, 3.4.3, and 3.4.4 apply the strategies to the four SWEIS Alternatives - No Action, Expanded, Reduced, and Greener. Section 3.4.5 summarizes and compares the implications of the various strategies.

3.4.1. Strategies Development and Assumptions

In developing the LLW management strategies, CTSD capabilities that are not viable within the 10 year time frame or which do not appear to be cost-effective were eliminated from further consideration. Technologies that do not benefit LLW management also were excluded. Table 3-2 lists the capabilities options that are applicable to the management of LLW generated at LANL in the next 10 years. Many of the listed capabilities are purposely generalized because a variety of technologies are available to effectively implement those capabilities. Table 3-2 also shows how each of the CTSD capabilities are implemented in the three LLW management strategies.

Formulation of the LLW management strategies and selection of the CTSD capabilities focused on the following objectives:

- Current Path.
  - Be consistent with current LANL waste management philosophy.
  - Consider cost effectiveness and practicality.

- Reflect current LLW management practice.

- Maximize existing onsite LLW disposal capabilities.

- Employ both onsite and offsite treatment capabilities to preserve LLW disposal capacity.

- Maximum Onsite.

  - Expand onsite LLW disposal capabilities.

  - Centralize LLW management activities.

  - Employ only onsite treatment capabilities.

- Minimum Onsite.

  - Minimize onsite LLW management operations.

  - Use offsite LLW disposal capabilities.

  - Use onsite disposal capabilities only when necessary.

  - Employ only necessary treatment capabilities to meet disposal WACs.

3.4.2. Current Path Strategy

The Current Path management strategy was applied to the 10 year projected LLW treatability group volumes for the four SWEIS alternatives presented in Section 3.2: No Action, Expanded, Reduced, and Greener. Process flow diagrams depicting the disposition of the LLW inventories under each of these alternatives are provided in Figures 3-2, 3-3, 3-4, and 3-5, respectively. The diagrams assume that LLW has been characterized and segregated into the 14 treatability groups by the waste generators. Hence, characterization and sorting/segregation processes are not explicitly depicted in the diagrams.

As shown in the process flow diagrams, under the Current Path strategy, disposal capacities in the Area G existing footprint, including constructed pits and new pits, are exceeded under all four SWEIS alternatives. The excess LLW disposal volumes can be accommodated by expanding Area G into either Zone 4 or Zone 5 SW, as described in Section 3.3.4. The disposition of the LLW inventories under the Current Path strategy is summarized in Table 3-3.

3.4.3. Maximum Onsite Strategy

Process flow diagrams depicting the disposition of LLW under the Maximum Onsite management strategy are provided in Figures 3-6, 3-7, 3-8, and 3-9 for the SWEIS No Action, Expanded, Reduced, and Greener alternatives, respectively. The process flow diagrams assume that LLW has been characterized and segregated by the waste generators into the 14 treatability groups. Consequently, characterization and sorting/segregation processes are not explicitly depicted in the diagrams.

As shown in the process flow diagrams, under the Maximum Onsite LLW management strategy, the disposal capacities in the Area G existing footprint are exceeded for all four SWEIS Alternatives. The excess LLW disposal volumes can be accommodated by expanding Area G into either Zone 4 or Zone 5 SW, as described in Section 3.3.4. The disposition of LLW under the Maximum Onsite management strategy is summarized in Table 3-4.

3.4.4. Minimum Onsite Strategy

The process flow diagrams depicting LLW disposition under the Minimum Onsite strategy are given in Figures 3-10, 3-11, 3-12, and 3-13 for the SWEIS No Action, Expanded, Reduce, and Greener alternatives, respectively. The diagrams do not explicitly account for waste characterization, sorting, or segregation because it is assumed that waste generators perform these activities.

Under the Minimum Onsite LLW management strategy, the disposal capacities in the Area G existing footprint are exceeded under all SWEIS alternatives. The excess LLW disposal volumes may be accommodated by expanding Area G into either Zone 4 or Zone 5 SW, as described in Section 3.3.4. The disposition of LLW under the Minimum Onsite strategy is summarized in Table 3-5.

3.5. Strategies Comparison

Tables 3-6 through 3-9 summarize and compare the results of the three LLW strategies on the basis of materials flowing through each of the strategy elements (characterization, treatment, storage, and disposal). Table 3-6 tabulates the No Action LLW volumes subject to the characterization, treatment, storage, and disposal (CTSD) capabilities under the Current Path, Maximum Onsite, and Minimum Onsite strategies. Tables 3-7, 3-8, and 3-9 present results for the Expanded, Reduced, and Greener alternatives, respectively.

Table 3-1. 10-year cumulative LLW inventories for the four SWEIS alternatives.

Treatability Group	No Action (m^3)	Expanded (m^3)	Reduced (m^3)	Greener (m^3)	Description
Total	90,126	120,920	88,497	100,586	
G01	6,918	11,002	6,731	9,068	Compactible / Combustible Waste
G02	10,496	14,423	9,997	10,930	Compactible / Non-Combustible Waste
G03	240	525	240	244	Non-Compactible / Combustible Waste
G04	13,573	22,938	12,936	14,255	Non-Compactible / Non-Combustible Waste
G05	41,068	47,033	40,995	45,858	Soil & Building Debris
G06	14,375	20,422	14,266	16,347	Scrap Metal
G07	64	353	59	350	High Activity Waste
G08	6	6	6	6	Tritium Waste
G09	412	872	412	412	Uranium Chips & Turnings[a]
G10	187	211	184	189	PCB Waste
G11	2,757	3,070	2,641	2,877	Asbestos Waste
G12	20	35	20	20	Beryllium Waste
G13	10	30	10	30	Biomedical Waste
G14	neglig.	neglig.	neglig.	neglig.	Classified Waste

a. Uranium chips and turnings were originally categorized as MLLW in the SWEIS waste projections (Rogers & Associates Engineering Corporation 1996) and are generated by the Machine Shops. Because the waste is more accurately defined as LLW, the appropriate adjustments were made to the projected LLW and MLLW inventories in this document.

Table 3-2. Implementation matrix for CTSD capabilities and LLW management strategies.

CTSD Capability	Current Path Model	Maximum onsite Model	Minimum onsite Model
Characterization			
Acceptable knowledge	Generator function	Generator function	Generator function
Sampling and analysis	Generator function	Generator function	Generator function
Treatment			
Sorting and segregation	Generator function	Generator function	Generator function
Supercompaction	Centralized onsite	Centralized onsite	Not used
Decontamination	Centralized onsite	Centralized onsite	Not used
Size reduction	Centralized onsite	Centralized onsite	Not used
Incineration	Offsite facility	Not used	Not used
Solidification / absorption	Generator function	Generator function	Generator function
U-Chips encapsulation	Generator function	Centralized onsite	Generator function
Storage			
Area G Domes	Not used	Not used	Not used
Disposal			
Area G existing footprint - constructed pits	Used	Used	Not used
Area G existing footprint - new pits	Used	Not used	Not used
Area G existing footprint - shafts	Used	Used	Used
Area G expansion - Zone 4	Used	Used	Not used
Area G expansion - Zone 5 SW	Used	Used	Not used
Nevada Test Site / Hanford	Not used	Not used	Used
Envirocare of Utah	Not used	Not used	Used

Table 3-3. Composite disposition of LLW inventories under the Current Path strategy.

SWEIS Alternative	As-Generated Volume (m3)	Net Volume Reduction	As-Disposed Volume (m3)	
No Action	104,376[a]	20%	100	Area G shafts
			26,000	Area G constructed pits
			10,000	Area G new pits
			47,137	Area G Zones 4 or 5 SW
Expanded	135,190[a]	23%	424	Area G shafts
			26,000	Area G constructed pits
			10,000	Area G new pits
			68,038	Area G Zones 4 or 5 SW
Reduced	102,747[a]	20%	95	Area G shafts
			26,000	Area G constructed pits
			10,000	Area G new pits
			46,087	Area G Zones 4 or 5 SW
Greener	114,836[a]	21%	406	Area G shafts
			26,000	Area G constructed pits
			10,000	Area G new pits
			54,273	Area G Zones 4 or 5 SW

a. Includes LLW that results from MLLW treatment.

Table 3-4. Composite disposition of LLW inventories under the Maximum Onsite strategy.

SWEIS Alternative	As-Generated Volume (m^3)	Net Volume Reduction	As-Disposed Volume (m^3)	
No Action	104,376[a]	20%	100	Area G shafts
			26,000	Area G constructed pits
			57,375	Area G Zones 4 or 5 SW
Expanded	135,190[a]	22%	424	Area G shafts
			26,000	Area G constructed pits
			78,558	Area G Zones 4 or 5 SW
Reduced	102,747[a]	20%	95	Area G shafts
			26,000	Area G constructed pits
			56,325	Area G Zones 4 or 5 SW
Greener	114,836[a]	21%	406	Area G shafts
			26,000	Area G constructed pits
			64,515	Area G Zones 4 or 5 SW

a. Includes LLW that results from MLLW treatment.

Table 3-5. Composite disposition of LLW inventories under the Minimum Onsite strategy.

SWEIS Alternative	As-Generated Volume (m^3)	Net Volume Reduction	As-Disposed Volume (m^3)	
No Action	104,376[a]	0%	70	Area G shafts
			55,318	Envirocare of Utah
			48,988	NTS / Hanford
Expanded	135,190[a]	0%	359	Area G shafts
			61,303	Envirocare of Utah
			73,528	NTS / Hanford
Reduced	102,747[a]	0%	65	Area G shafts
			55,245	Envirocare of Utah
			47,437	NTS / Hanford
Greener	114,836[a]	0%	356	Area G shafts
			60,108	Envirocare of Utah
			54,372	NTS / Hanford

a. Includes LLW that results from MLLW treatment.

Table 3-6. Comparison of waste flows for management strategies applied to the No Action alternative.

CTSD Capability	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	104,376[a]	104,376[a]	104,376[a]
Treatment			
Onsite treatment	32,201	32,201	412
Offsite treatment	240	0	0
No treatment	57,685	57,925	89,714
Crossover from MLLW treatment	14,250	14,250	14,250
Storage	0	0	0
Disposal			
Area G existing footprint - constructed pits	26,000	26,000	0
Area G existing footprint - new pits	10,000	0	0
Area G existing footprint - shafts	100	100	70
Area G expansion - Zone 4 / 5 SW	47,137	57,375	0
Envirocare of Utah	0	0	55,318
Nevada Test Site / Hanford	0	0	48,988

a. Includes LLW that results from MLLW treatment.

Table 3-7. Comparison of waste flows for management strategies applied to the Expanded alternative.

CTSD Capability	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	135,190[a]	135,190[a]	135,190[a]
Treatment			
Onsite treatment	46,719	46,719	872
Offsite treatment	525	0	0
No treatment	73,676	74,201	120,048
Crossover from MLLW treatment	14,270	14,270	14,270
Storage	0	0	0
Disposal			
Area G existing footprint - constructed pits	26,000	26,000	0
Area G existing footprint - new pits	10,000	0	0
Area G existing footprint - shafts	424	424	359
Area G expansion - Zone 4 / 5 SW	68,038	78,558	0
Envirocare of Utah	0	0	61,303
Nevada Test Site / Hanford	0	0	73,528

a. Includes LLW that results from MLLW treatment.

Table 3-8. Comparison of waste flows for management strategies applied to the Reduced alternative.

CTSD Capability	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	102,747[a]	102,747[a]	102,747[a]
Treatment			
Onsite treatment	31,406	31,406	412
Offsite treatment	240	0	0
No treatment	56,851	57,091	88,085
Crossover from MLLW treatment	14,250	14,250	14,250
Storage	0	0	0
Disposal			
Area G existing footprint - constructed pits	26,000	26,000	0
Area G existing footprint - new pits	10,000	0	0
Area G existing footprint - shafts	95	95	65
Area G expansion - Zone 4 / 5 SW	46,087	56,325	0
Envirocare of Utah	0	0	55,245
Nevada Test Site / Hanford	0	0	47,437

a. Includes LLW that results from MLLW treatment.

Table 3-9. Comparison of waste flows for management strategies applied to the Greener alternative.

CTSD Capability	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	114,836[a]	114,836[a]	114,836[a]
Treatment			
Onsite treatment	36,757	36,757	412
Offsite treatment	244	0	0
No treatment	63,585	63,829	100,174
Crossover from MLLW treatment	14,250	14,250	14,250
Storage	0	0	0
Disposal			
Area G existing footprint - constructed pits	26,000	26,000	0
Area G existing footprint - new pits	10,000	0	0
Area G existing footprint - shafts	406	406	356
Area G expansion - Zone 4 / 5 SW	54,273	64,515	0
Envirocare of Utah	0	0	60,108
Nevada Test Site / Hanford	0	0	54,372

a. Includes LLW that results from MLLW treatment.

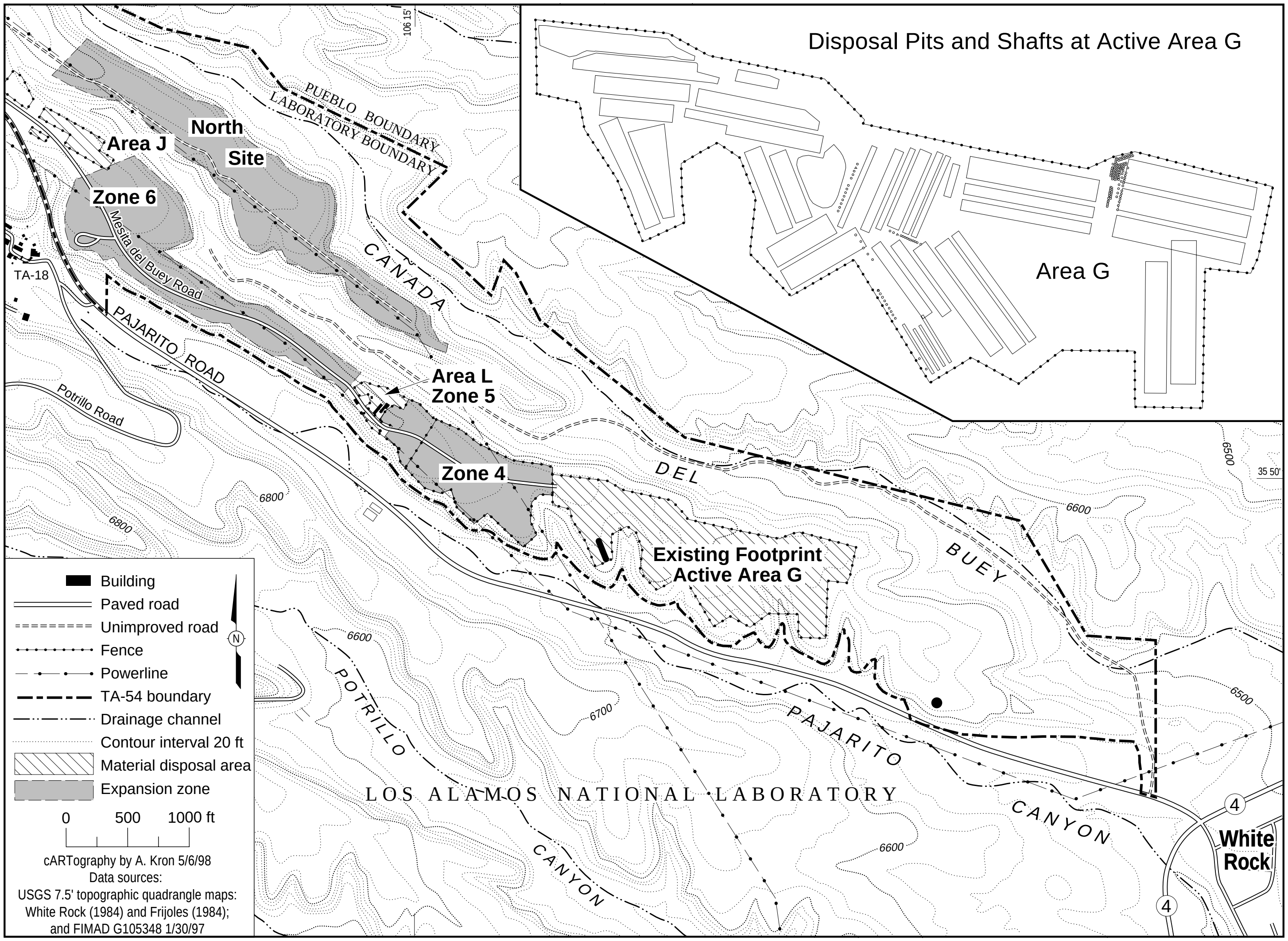

Figure 3-1. Map of TA-54 Area G.

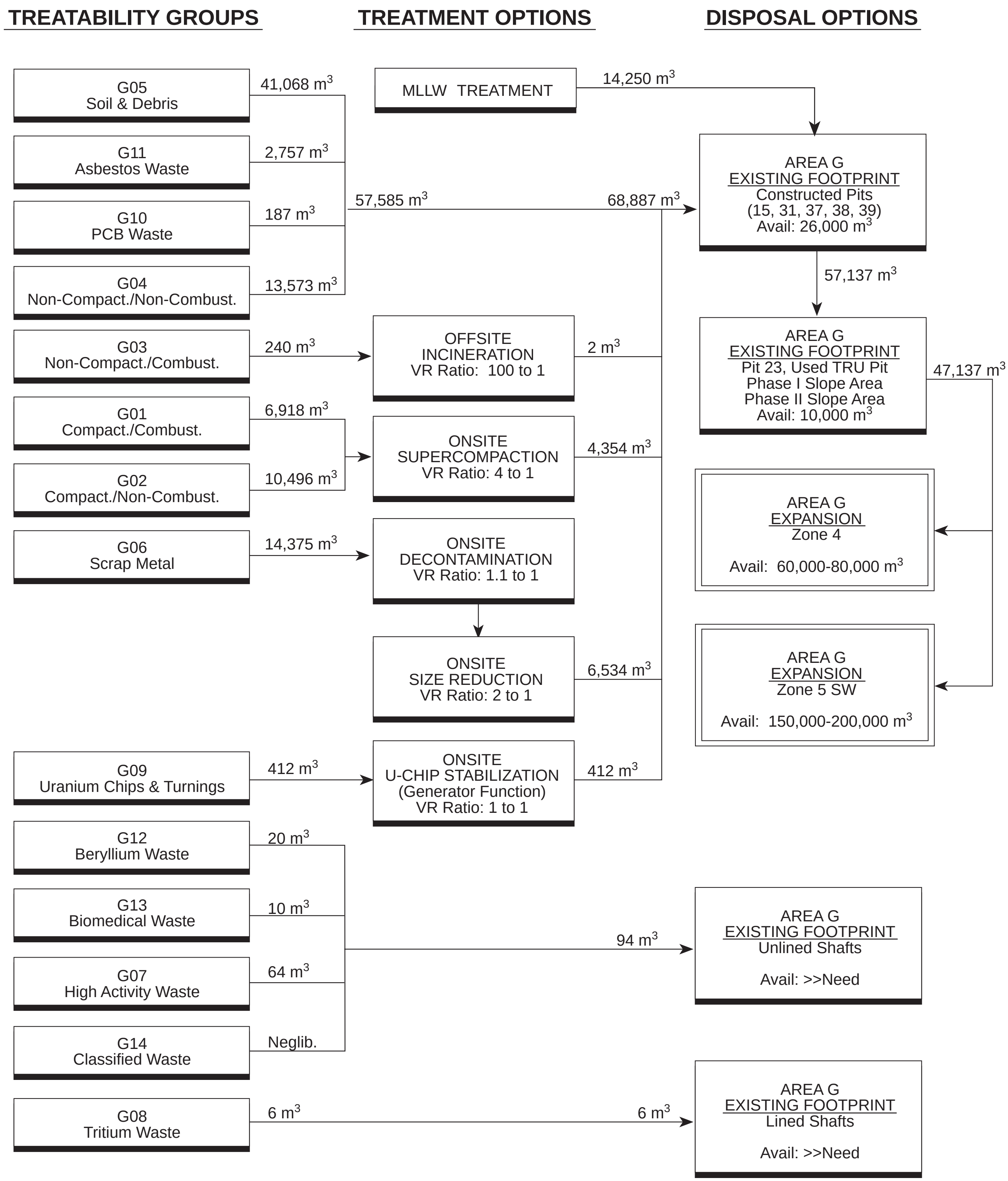

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Figure 3-2. Current Path Strategy for No Action LLW Volumes.

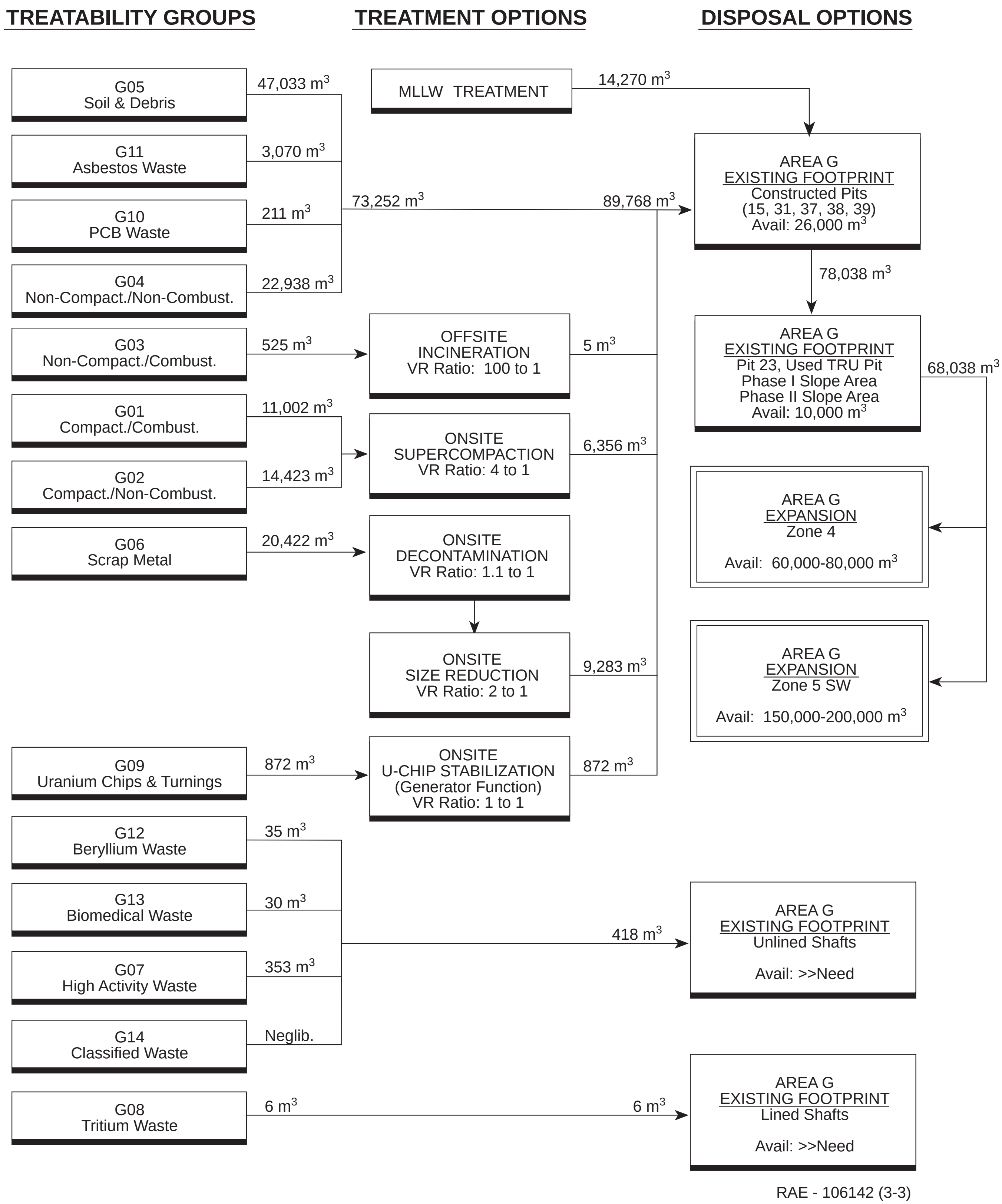

Figure 3-3. Current Path Strategy for Expanded LLW Volumes.

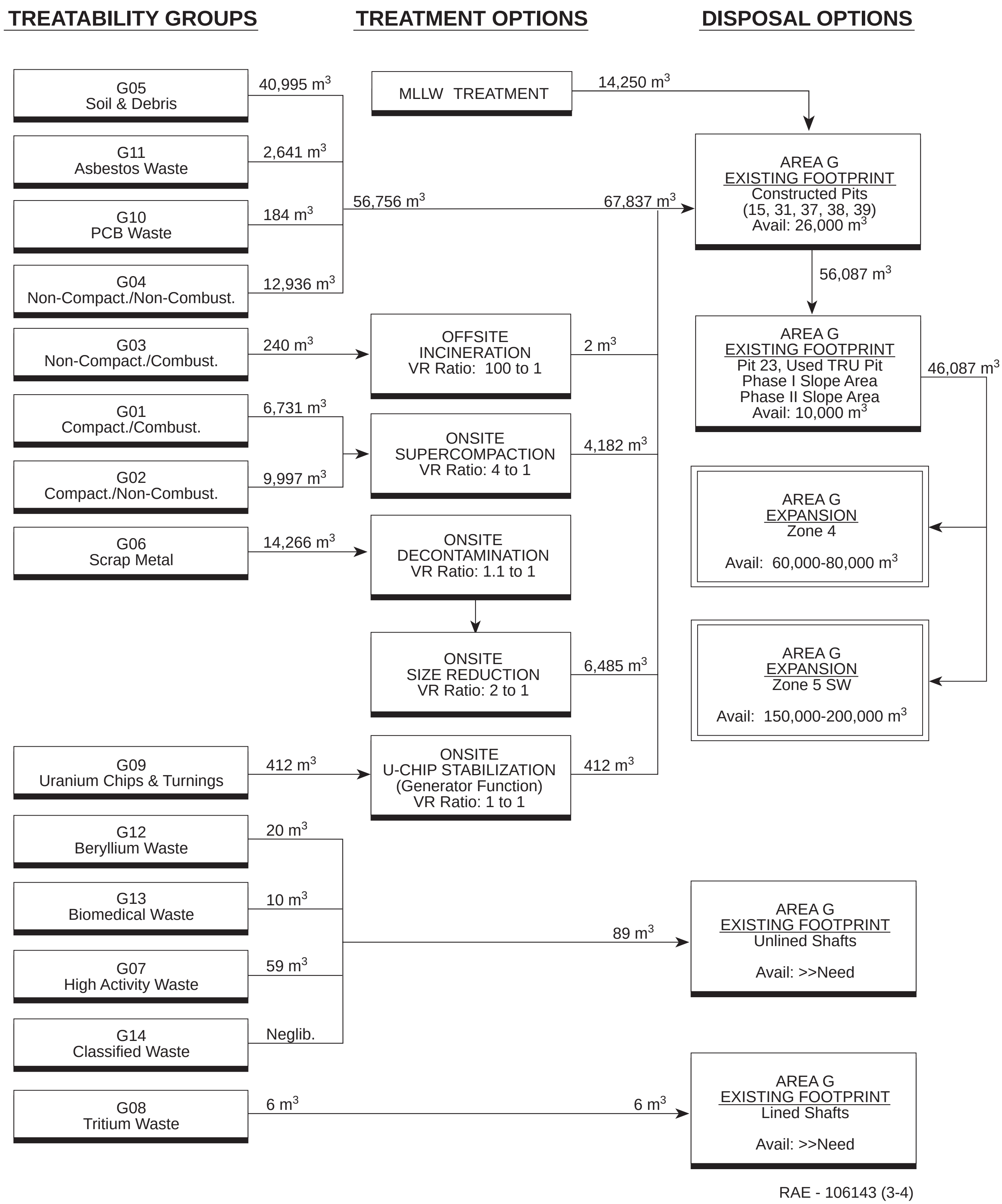

Figure 3-4. Current Path Strategy for Reduced LLW Volumes.

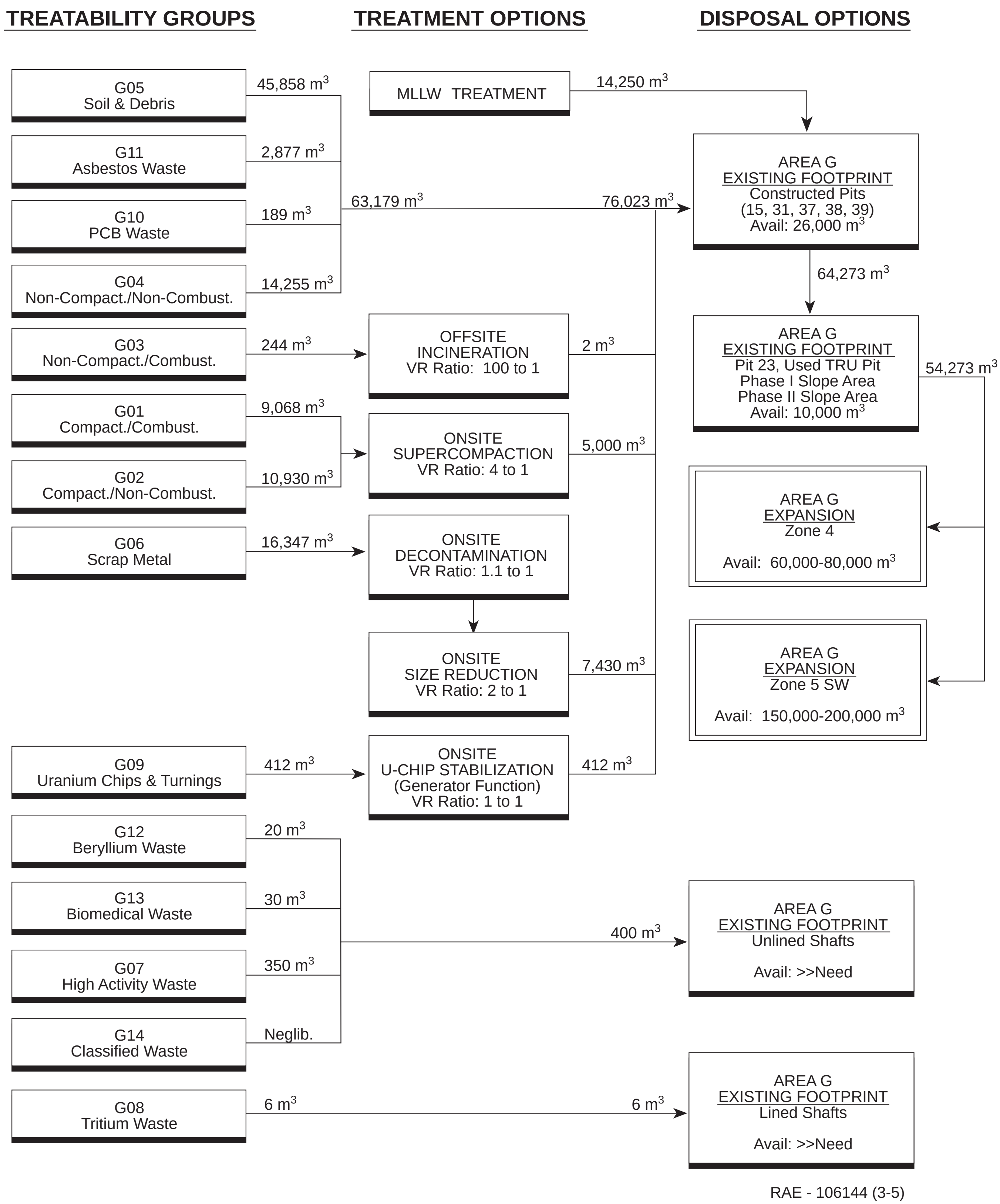

Figure 3-5. Current Path Strategy for Greener LLW Volumes.

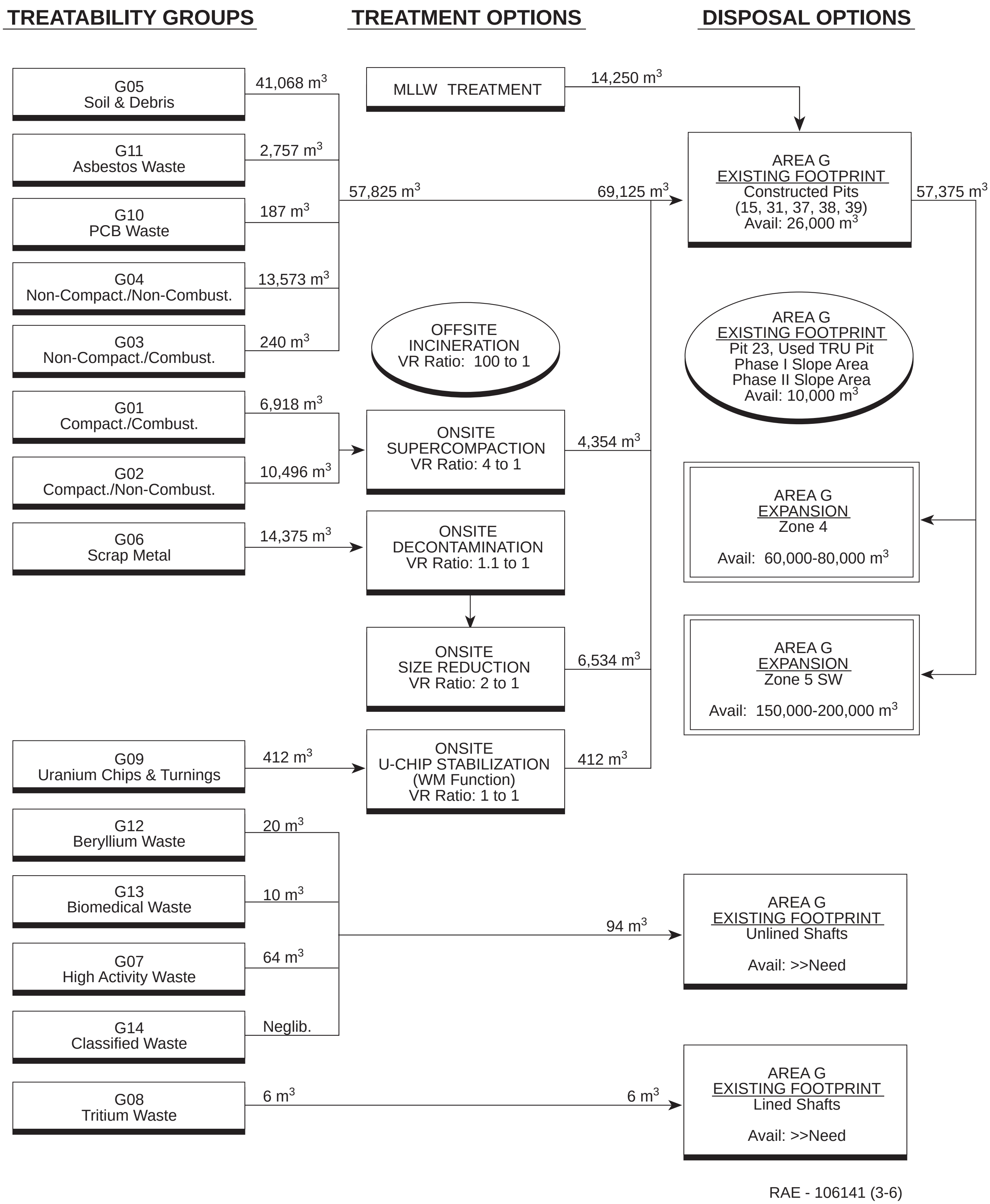

Figure 3-6. Maximum Onsite Strategy for No Action LLW Volumes.

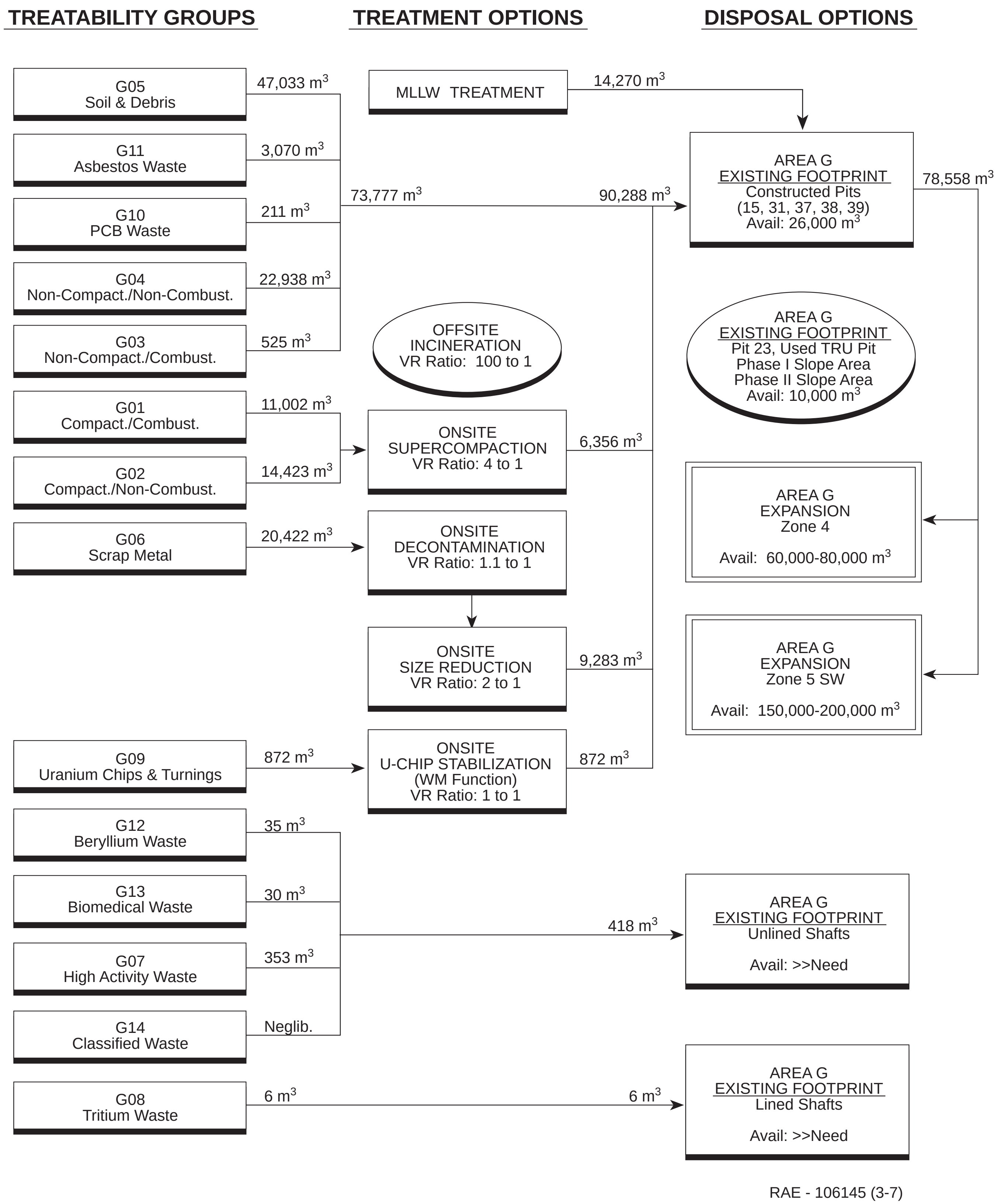

Figure 3-7. Maximum Onsite Strategy for Expanded LLW Volumes.

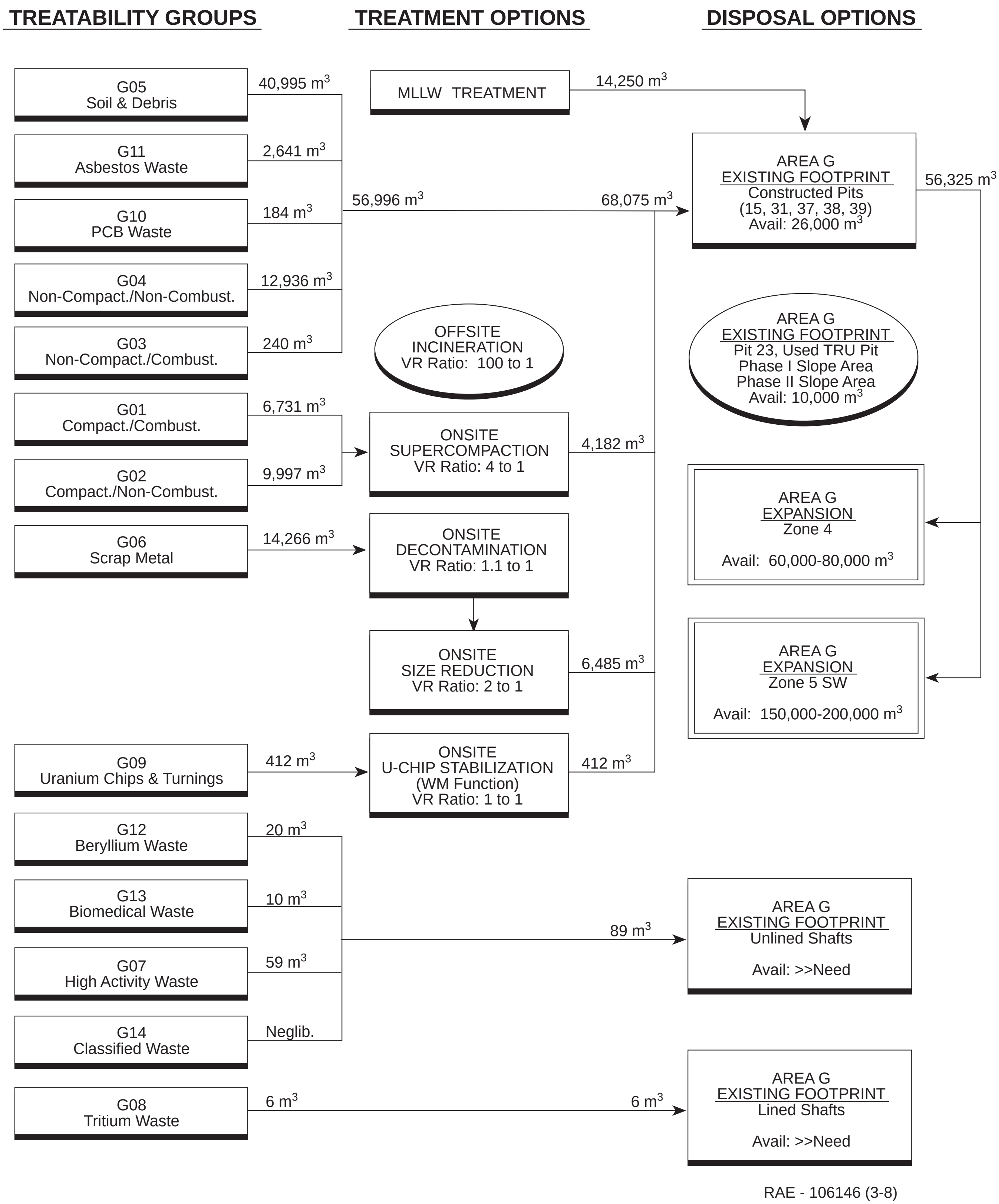

Figure 3-8. Maximum Onsite Strategy for Reduced LLW Volumes.

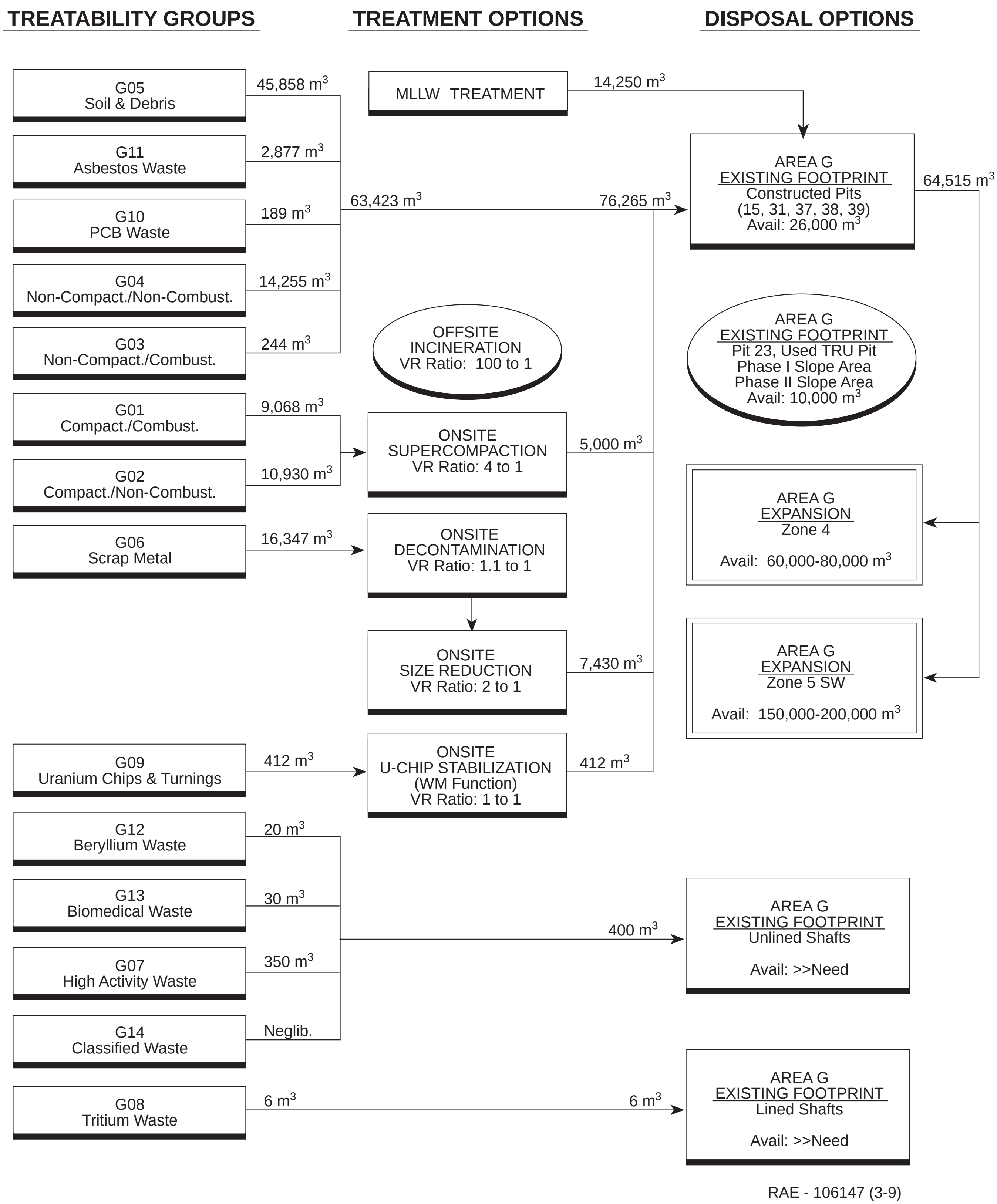

Figure 3-9. Maximum Onsite Strategy for Greener LLW Volumes.

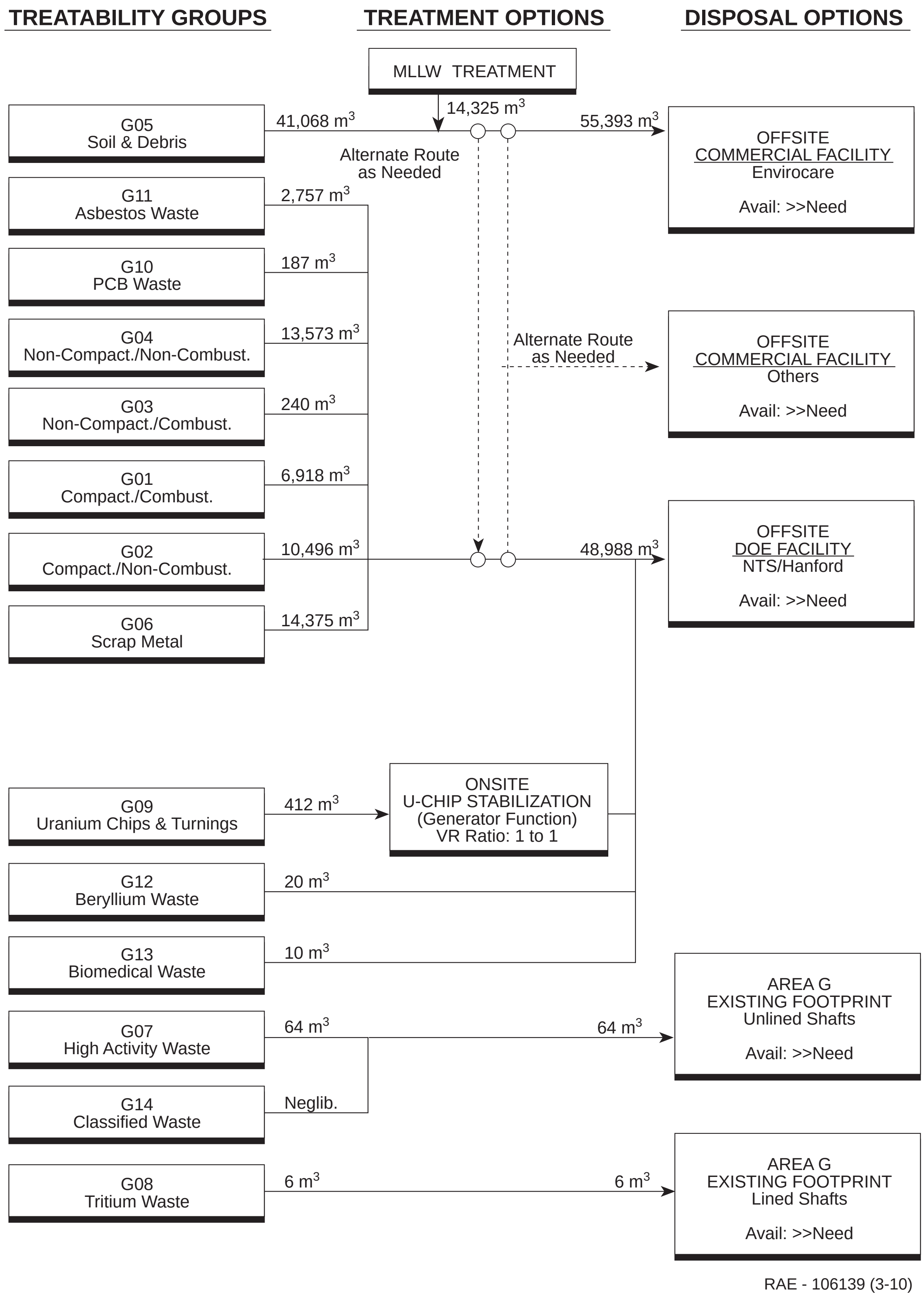

Figure 3-10. Minimum Onsite Strategy for No Action LLW Volumes.

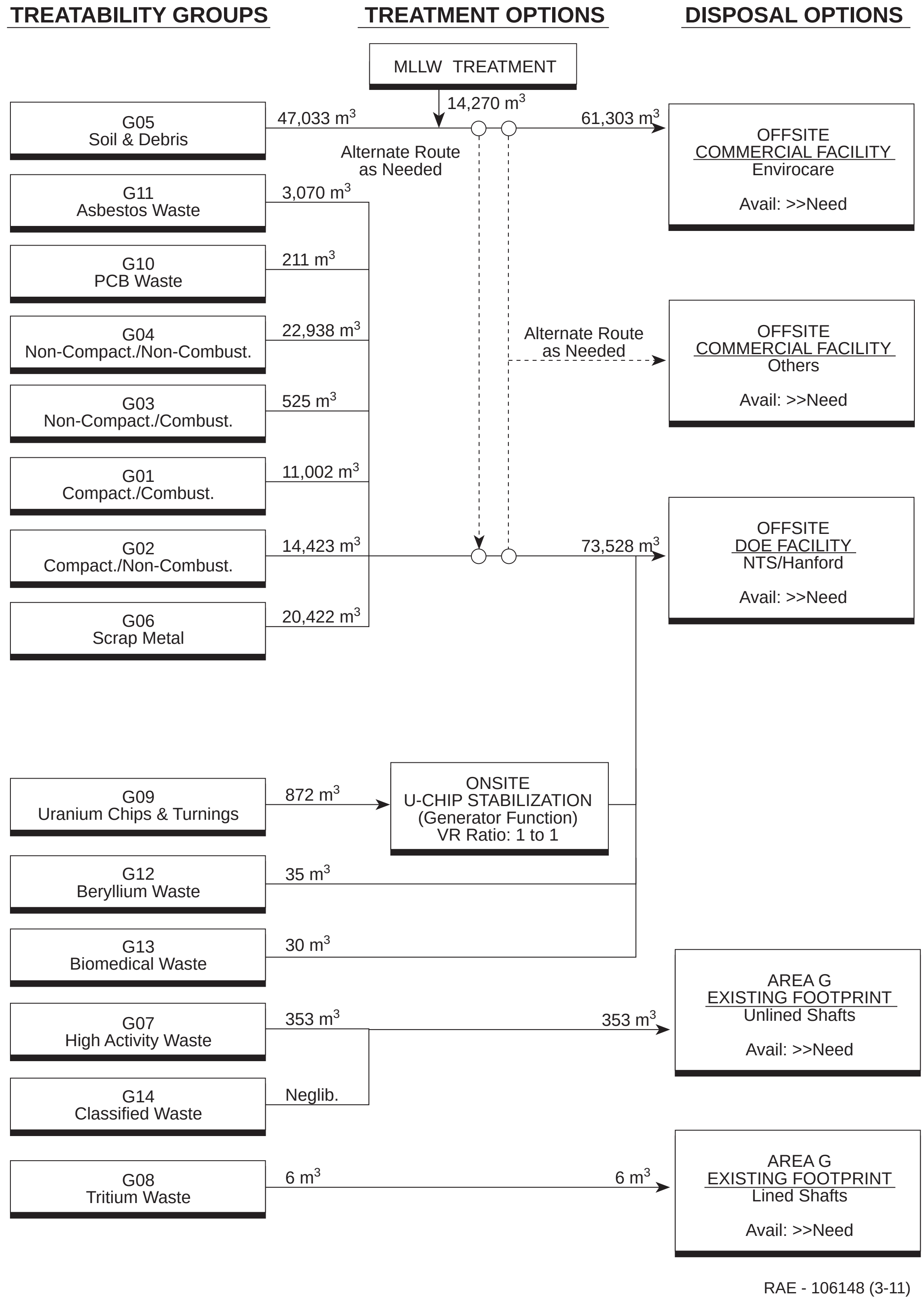

Figure 3-11. Minimum Onsite Strategy for Expanded LLW Volumes.

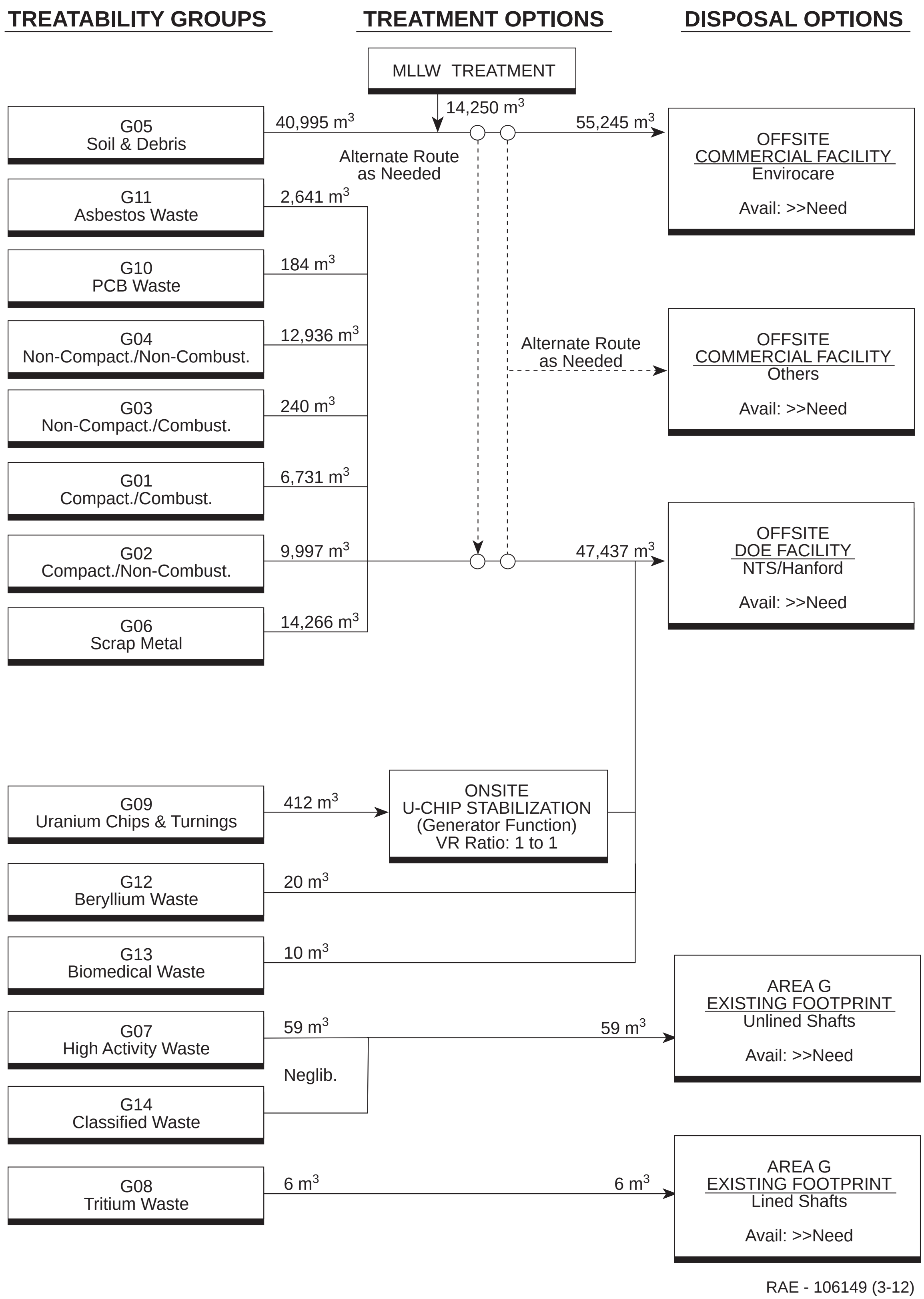

Figure 3-12. Minimum Onsite Strategy for Reduced LLW Volumes.

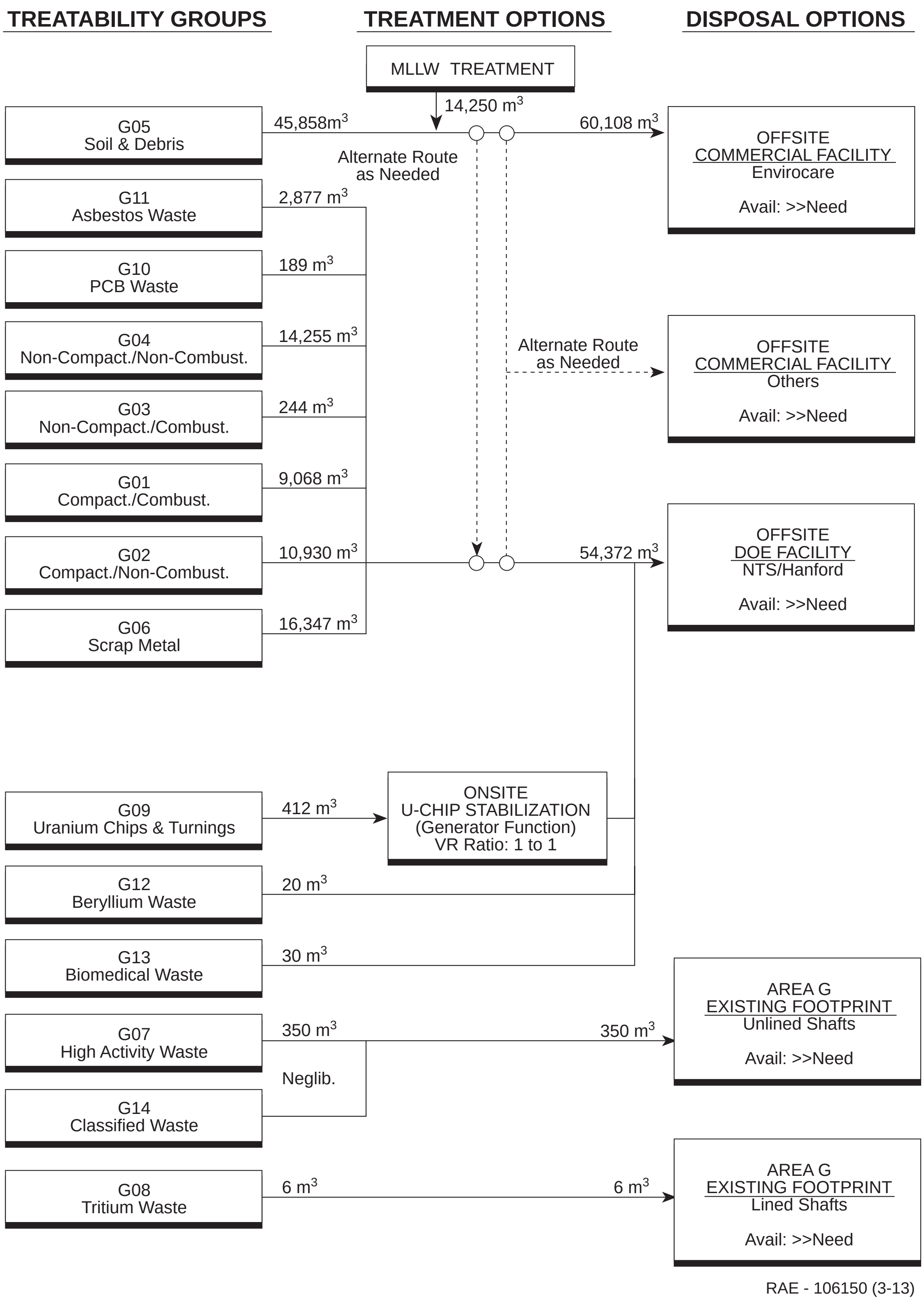

Figure 3-13. Minimum Onsite Strategy for Greener LLW Volumes.

4. TRANSURANIC WASTE MANAGEMENT STRATEGY

This chapter describes the general characteristics of TRU waste, its generation at LANL, and the elements of its management. Three strategy models - Current Path, Maximum Onsite, and Minimum Onsite - for managing TRU waste in the next 10 years are postulated and evaluated.

4.1. TRU Waste Definitions and Descriptions

TRU waste is material contaminated with alpha emitting transuranium radionuclides with half lives greater than 20 years and radioactive concentrations greater than 100 nCi/g at the time of assay. This definition applies regardless of the waste's source or form. Transuranium radionuclides are any radionuclides with atomic numbers greater than 92.

TRU waste containing hazardous components as defined by RCRA is labeled mixed TRU waste (LANL 1994, DOE 1988). It is estimated that approximately 95 percent of the TRU waste at LANL is mixed TRU waste (LANL 1996). Since both types of waste are managed together at LANL, they are collectively referred to as TRU waste, although distinctions between the two are made when necessary. TRU waste also is classified as remote handled waste if the external exposure rate at the surface of the waste container exceeds 200 mrem/hr (otherwise, the waste is classified as contact handled).

TRU waste is further defined by TRUCON codes, which provide information on waste package composition. In its preparations to ship waste to the Waste Isolation Pilot Plant (WIPP) for disposal (as directed by the DOE), LANL has in recent years categorized TRU waste held in storage according to "treatability groups." These groups are listed in Section 4.2. These designations consolidate similar wastes that may be subjected to common management and processing practices.

TRU waste is generated primarily by the following four facilities at LANL:

- Nuclear Materials Technology (TA-55).
- CMR.
- Radioactive Liquid Waste Treatment Facility (RLWTF).
- WCRRF.

Of these facilities, only TA-55 and CMR generate TRU waste directly. The RLWTF generates TRU waste from the treatment of radioactive liquid waste from TA-55; the WCRR Facility produces it from waste size reduction activities. TRU waste from TA-55 and CMR results from activities such as plutonium processing, pit production, plutonium research and development, actinide processing and recovery, nuclear fuel fabrication, analytical chemistry support, radioactive source recovery, and metallurgy research.

It is anticipated that in the next 10 years another LANL facility, the Firing Sites, will also begin generating small quantities of TRU waste from its operations with the Dual Axis Radiographic Hydrodynamic Test Facility. ER projects are also expected to generate some TRU waste within the same time frame.

4.2. TRU Waste Inventories

TRU waste requiring management and disposal in the next 10 years includes:

- Waste projected to be generated under the four SWEIS alternatives.
- Waste currently placed in interim/inspectable storage.

- Legacy waste placed in retrievable/uninspectable storage.

The volumes of TRU waste projected to be generated for the No Action, Expanded, Reduced, and Greener SWEIS alternatives are 2,719 m^3, 5,486 m^3, 2,159 m^3, and 2,753 m^3, respectively (Rogers & Associates Engineering Corporation 1996). These projections include contributions from CMR, TA-55, the Firing Sites, Waste Management facilities, and ER projects. The Capability Maintenance Improvement Project and upgrade of the CMR Facility are not expected to produce any TRU waste. The waste projections and their development are described in detail in the SWEIS Waste Projections Data Package (Rogers & Associates Engineering Corporation 1996).

LANL also has approximately 9,014 m^3 of TRU waste placed in interim/inspectable and retrievable/uninspectable array. The TRU waste placed in retrievable/uninspectable array is referred to as legacy waste. This waste was placed in shafts and earth covered pits and trenches at Area G, and could be retrieved and placed in interim/inspectable storage at TA-54, Area G (in protective domes). Another 2,596 m^3 of legacy waste is considered "buried," meaning that it cannot be safely retrieved for placement in interim/inspectable storage.

As mentioned in Section 4.1, TRU waste is categorized in treatability groups. Such designations facilitate identification and proper disposition of the waste. The groups are defined by Baseline Inventory Report Waste Stream (BIR_WS) codes and descriptions contained in the TRU waste inventory database maintained by LANL's CST-14 Group. All LANL generated TRU waste packages are assigned a BIR_WS code. These codes allow historical waste records for given wastes to be compiled, a process which eventually yields total waste volumes for the respective treatability groups. Table 4-1 shows the treatability group volumes for TRU waste in storage as of December 31, 1995 (LANL 1996c). The table includes TRU waste that is in retrievable and interim/inspectable storage, as well as that which is considered "buried."

TRU waste inventories projected for the four SWEIS alternatives were also distributed according to BIR_WS codes or treatability groups. The distributions were developed based on historical percentages obtained from the BIR_WS codes for each of the generating facilities. The period spanning 1986 to 1995 was used to determine the representative distributions. This period is longer than those used to establish the baseline for the gross inventories projections (Rogers & Associates Engineering Corporation 1996) and captures a wider spectrum of treatability groups. The period was not extended to the years before 1986 because data from earlier years are not as reliable as the more recent data. The 1986 to 1995 data also best represent LANL's current operations waste management practices, and waste characteristics. Finally, because no historical profile exists for ER wastes, the corresponding projected volumes were assigned to the LA M17 "Unknown Miscellaneous Waste" category.

The projected TRU waste treatability group volumes were combined with the legacy and stored waste inventories shown in Table 4-1 to yield the total TRU waste inventories that need to be addressed in the next 10 years. The combined TRU waste inventories are presented in Table 4-2 for the four SWEIS alternatives. As illustrated by differences between Table 4-1 and Table 4-2, most TRU waste requiring management in the next 10 years is either in interim storage or legacy waste. Newly generated TRU waste comprises only 16 to 32 percent of the total inventories, depending on the SWEIS alternative.

4.3. TRU Waste Management Elements

Management of TRU waste at LANL is driven by federal and state regulatory requirements, DOE policies and guidance (in particular, DOE Order 5820.2A "Radioactive Waste Management" [DOE 1988]), funding levels, available cost effective technologies, storage and disposal capacities, and projected waste volumes. TRU waste management is implemented through the CST Waste Management Facilities Waste Acceptance Criteria and Certification (LANL 1994), as well as through other administrative and detailed operating procedures in place at generating facilities and waste management facilities.

Four elements were considered in developing LANL's waste management strategy alternatives:

- Characterization.
- Treatment.
- Storage.
- Disposal.

Since the ultimate disposition of the TRU Waste is disposal, most of the precursor strategy elements are implemented to ensure that regulation compliant and environmentally safe disposal of the TRU can be achieved. The following sections describe these strategy elements and identify options available to successfully and effectively implement each waste management strategy.

4.3.1. Characterization

Waste characterization involves identifying and quantifying constituents of concern in waste streams. The purpose of waste characterization is to ensure that wastes are managed in accordance with regulatory classification and requirements and are safely handled, transported, stored, and disposed. Characterization is the first step in ensuring that TRU waste destined for disposal at the Waste Isolation Pilot Plant meets all applicable waste acceptance criteria. Currently, the WIPP Waste Acceptance Criteria, Revision 5 (DOE 1996), specify constraints for the following parameters:

- Container type.
- Weight limit.
- Flammable constituents.
- Plutonium fissile gram equivalents.
- TRU curie limit.
- EPA constituents.
- Thermal power limit.

Characterization techniques that are currently implemented at LANL fall under two broad categories: (a) acceptable knowledge (AK) and (b) sampling and analysis (LANL 1994). These characterization techniques are described in the following paragraphs.

4.3.1.1. Acceptable Knowledge

AK refers to information used for waste characterization in place of direct waste sampling and analysis. AK includes process knowledge and previous chemical/analytical results associated with the waste. The AK technique involves documenting the raw materials used in a process or operation, the associated material safety data sheets, the products produced, and the associated waste produced. It also involves knowing the facility or process history and all previous and current activities that affect the facility or process that generate the waste. By properly documenting and certifying the AK to be accurate, a generator may then deduce the chemical composition, radionuclide content, and physical form of each waste stream. TRU waste generators apply the AK technique to characterize wastes when the same type of waste is repeatedly produced by a process or operation.

4.3.1.2. Sampling and Analysis

The sampling and analysis technique provides the most direct and usually the most accurate waste characterization information, provided it is performed correctly and on representative waste samples. Proper sampling and analysis techniques can be ensured by using a sampling and analysis plan that documents the analytical techniques employed, sample handling procedures, and quality assurance and quality control considerations. Sampling and analysis techniques employed for TRU waste characterization may include direct radiological assays or indirect radiological measurement. The former technique relies on analytical measurements using gamma spectroscopy, passive and/or active neutron scanning, liquid scintillation counting, gross alpha/beta counting, and alpha spectroscopy. The latter technique relies on (a) characterization by source, which traces the origin and history of the waste; (b) use of scaling factors, where the activity of one radionuclide is inferred from the measured activity of another radionuclide; (c) gross radiation measurements, where exposure rates measured in units of mR/hr are converted into estimated activities for certain gamma emitting radionuclides using published gamma factors; or (d) calculations, where contamination levels are theoretically derived.

To ship waste to WIPP for disposal, LANL is required to demonstrate through direct sampling and analysis of statistically representative populations that the TRU waste packages meet the WIPP Waste Acceptance Criteria. The level of sampling and analysis required and the numbers of packages that must be subjected to evaluation depend on how certain the knowledge is of the operations and processes that generated the waste. Thus, TRU waste characterization is achieved by applying a combination of AK and sampling and analysis techniques. For newly generated waste, characterization may rely more on AK technique and less on sampling and analysis; for legacy waste, sampling and analysis normally prove more reliable. To adequately characterize TRU waste for shipment to WIPP, LANL is required to implement the following direct characterization:

- Non destructive assay/non destructive examination.
- Visual inspection of drum contents.
- Core sampling (solidified sludge).
- Organics analysis.
- RCRA metals analysis.

The capabilities that LANL and DOE currently have or are developing to meet the TRU waste characterization requirements are listed in Table 4-3 (LANL 1996). In the analysis of the TRU waste strategies, these capabilities were collectively included as part of the characterization process. The capabilities are detailed here to demonstrate that the characterization technologies exist to facilitate compliance with the WIPP Waste Acceptance Criteria.

4.3.2. Treatment

Treatment of TRU waste may be necessary to meet the WIPP WACs. Treatment may also be needed to reduce bulky items to a size that will fit into a shipment or particular disposal container. The types of treatment that LANL may need to perform to meet the WIPP Waste Acceptance Criteria are:

- Drum preparation.
- Overpacking.
- Drum venting.
- Size reduction.

- Decontamination.
- Compaction.
- Incineration.
- Repackaging.
- Special-case waste treatment.

Although LANL has developed and continues to develop technology for treating certain categories of TRU waste, it has not identified a capability or facility for treating large volumes of wastes. Hence, it is desirable that newly generated waste be managed in a manner that minimizes the amount of treatment necessary. Because a majority of the waste requiring treatment is in interim storage or legacy waste, it is envisioned that TRU waste treatment capabilities would be centralized on site. The following paragraphs describe the treatment options and technologies listed above and discuss the viability of using each to manage LANL's TRU waste in the next 10 years.

4.3.2.1. Drum Preparation

Drum preparation involves steam cleaning retrieved waste drums in support of the TRU Waste Inspectable Storage Program (TWISP) and possibly other future TRU waste retrieval programs. Steam cleaning removes rust inhibitor from the drum's exterior, thus facilitating future inspection and evaluation of surface contamination levels and exterior corrosion. Drum cleaning is conducted in the Drum Preparation Facility (DPF) at TA-54, Area G. The DPF will also provide an enclosed decontamination/washdown pad to clean vehicles and equipment that may become contaminated during the TWISP or other activities at TA-54, such as glovebox decontamination.

4.3.2.2. Overpacking

Overpacking of waste containers is performed as needed to ensure that the integrity of TRU waste containers is maintained during storage, as required by RCRA. Typically, overpacking involves placing waste containers into 55 or 85 gallon drums, or into standard waste boxes (SWBs or metal boxes). It is anticipated that overpacking activities can take place in the DPF or in storage domes at TA-54, Area G.

4.3.2.3. Drum Venting

The WIPP Waste Acceptance Criteria require that all waste packages shipped in TRUPACT II (the mandated transportation container for WIPP) be vented with one or more specified filters, and that all rigid liners be punctured or vented. LANL complies with these criteria by venting drums with the Mobile Drum Venting System (DVS). This system safely vents up to 55 gallon drums and installs a filter vent in each. The DVS can also be used for headspace gas sampling, as stated in Table 4-3.

4.3.2.4. Size Reduction

Large bulky items, such as gloveboxes, piping, scrap metal, and equipment, may need to be reduced in size to fit into 55 gallon drums or SWBs. In the past, LANL has conducted (and plans to continue conducting) size reduction operations at the WCRRF, TA-50-69. At this facility, a plasma torch is used to cut TRU contaminated large, bulky, metallic items into smaller pieces. These pieces then are repackaged into SWBs. Size reduction operations typically yield volume reduction factors of about 4 to 1 or 5 to 1. Operations with the potential for significant radiation exposure are conducted inside a large glovebox; those with a lesser potential for exposure could be performed inside the enclosure airlock. Operations that require minimal containment could be performed in the process room. Operations at the WCRRF are expanding to support waste inspection and sampling activities, as well as other evolving waste management operations.

4.3.2.5. Decontamination

Decontamination reduces the volume of materials that may be considered regulated waste and facilitates recovery of expensive equipment and reusable items. For example, a large TRU contaminated waste item may be decontaminated to a level where it could be considered clean, or to a level where it would be classified as LLW. This process would in turn generate only a small volume of TRU waste residue or by product. Managing a large volume of LLW is much cheaper than managing an equal volume of TRU waste. Items that are potential decontamination candidates include gloveboxes, stainless steel components, exotic metal parts, piping, and hardware.

Decontamination of solid waste articles with removable contamination has been demonstrated for a wide range of materials and removal techniques. Decontamination can be accomplished by washing the contaminated surface with chemical surfactants and abrading the surface with high pressure streams of water, sand blasting, or dry ice blasting. Other, more complex decontamination techniques include electrolytic decontamination, plasma decontamination, electrokinetics, and radioactive sorting. The first two of these techniques are applicable to metallic waste streams; the latter two apply to soils and debris wastes. Although electrokinetics and radioactive sorting may generally be referred to as soil remediation, they do fit within the context of decontamination, whose purpose is to reduce the volume of regulated waste. Table 4-4 describes the decontamination capabilities in more detail and discusses their applicability to managing LANL's TRU waste.

Decontamination is a labor intensive process. While the limiting factor for some techniques may be the equipment required to employ them, that for decontamination often is the experience of equipment operators and their understanding of the waste articles requiring decontamination. Decontamination may be carried out in any area in which ventilation and spill control can be ensured. Because decontamination generally is a manual operation, it may subject workers to increased risks of radiation exposure.

Presently, decontamination of newly generated TRU waste is performed by the generating facilities themselves because they have the equipment and personnel to handle highly contaminated items. Decontamination activities related to legacy waste retrieval operations will be conducted at the DPF at TA-54, Area G. It may also be possible to conduct decontamination operations in the WCRRF at TA-50-69.

4.3.2.6. Compaction

Compaction reduces the volume of waste packages by minimizing the void space within them. Depending on the material being compacted and the force applied, the bulk density of a compacted form could reach its true density. Because compaction reduces the volume of a waste package, the radionuclide concentrations in that waste package increase inversely with the degree of compaction.

At the present time, LANL does not have compaction capability for TRU waste, although it does have a supercompactor being used for LLW. In the past, LANL also has used a low force compactor for LLW. Although volume reduction is usually recommended for most wastes, compaction of TRU waste is not desirable because of the higher TRU radionuclide concentrations it would create. These higher concentrations and their resultant heat generation potentially could exceed transportation requirements related to disposal of TRU waste at Waste Isolation Pilot Plant (WIPP), which impose restrictions on the thermal emanating power of TRU waste packages. Compaction of TRU waste also is not desirable because of the higher radiation exposure rates associated with handling the compacted TRU waste packages. Therefore, compaction is not a viable option for TRU waste management.

4.3.2.7. Incineration

Incineration is a thermal treatment process that subjects waste to high-temperature combustion to produce stable ash, water vapor, and carbon dioxide under controlled conditions. Incineration is used widely for high-volume reduction applications and for destruction of toxic organic compounds in hazardous wastes. For cellulosic wastes (such as paper, wood, rags, and lab coats), incineration can achieve volume reduction ratios as high as 400 to 1. The volume reduction possible for metallic waste, salts, concrete rubble, and soils is naturally much less than that for cellulosic wastes. Incineration also can be used to stabilize organic compounds by converting them into oxides in the form of ash or slag.

Although incineration may be a highly effective treatment process in terms of volume reduction, it also is expensive. An incinerator must incorporate the sophisticated energy control and off gas treatment systems required for efficient and safe operation. Furthermore, well more than a decade may be required to design, construct, test, and permit an incinerator for TRU waste. Efforts to develop radioactive waste incinerators also often meet significant opposition from the public and regulators because of concerns regarding the potential for atmospheric releases.

While no capability for incineration of TRU waste exists within either the DOE or the commercial sector, a controlled-air incinerator was operational at LANL through fiscal year 1996. The system was designed and constructed to demonstrate how controlled-air incineration could convert LANL generated radioactive and chemical wastes to more stable waste forms with the consequent waste volume reductions. However, due to difficulties in permitting the system and changes in DOE policy, the incinerator was dismantled in 1996.

Besides high development costs, difficulty in permitting, and public opposition, incineration as a means for volume reduction is also not desirable for TRU wastes because it increases radionuclide concentrations in the waste. This increase creates the same regulatory problem as that posed by the increase tied to waste compaction. For this reason and those cited previously, incineration is not a viable option for TRU waste management.

4.3.2.8. Repackaging

Repackaging involves removing, sorting, and placing the contents of TRU waste packages into appropriate containers. The contents of TRU waste packages may need to be repackaged to meet the restrictions imposed by the WIPP Waste Acceptance Criteria. This process may involve placing waste contents in appropriate containers, lowering radionuclide concentrations in the waste package, and removing non-complying objects from the waste package.

At the present time, repackaging operations at LANL can be conducted inside two waste characterization gloveboxes equipped with drum-handling units for emptying waste contents inside the glovebox. Each waste characterization glovebox is equipped with internal high-efficiency particulate air (HEPA) filters for inlet and exhaust air, and with a sump to contain free liquids from the waste. The gloveboxes currently are located at the WCRRF.

4.3.2.9. Special-Case Treatment

A case-by-case treatment capabilities evaluation must be conducted for special-case TRU waste that, due to the lack of information and uncertainties regarding unretrieved legacy waste or waste projected to be generated, has not been characterized. Such treatment options will have to be evaluated when the need to do so actually arises.

4.3.2.10. LDR Treatment

Due to the Federal Facility Compliance Order and Site Treatment Plan issued by the New Mexico Environment Department (1995), LANL may have to treat mixed TRU waste to meet the requirements of the U.S. Environmental Protection Agency's Land Disposal Restrictions (LDR). However, the WIPP Land Withdrawal Amendments Act of 1996 exempted mixed TRU waste designated by the Secretary of Energy for disposal at WIPP from the LDR. It is anticipated that most, if not all, of LANL's mixed TRU currently in storage will be subject to this designation by the Secretary. Although existing capabilities for the treatment of mixed TRU waste are limited, various technological innovations are being tested and developed by the DOE and industrial partners to address the stabilization of mixed TRU waste and MLLW. Tables 4-5 and 4-6 summarize and describe these technologies and their potential application in treating mixed TRU Waste to conform to LDR requirements.

Table 4-5 lists thermal treatment technologies that involve high-temperature processes. Table 4-6 lists the non thermal treatment technologies that involve relatively low-temperature conditions. As discussed earlier, incineration as a thermal treatment technology is not included in Table 4-5 because of its high development cost, difficulty to permit, and public opposition. Although most of the technologies listed in Table 4-5 generally are being developed for the treatment of MLLW, it is anticipated that in many cases the same underlying technologies will be adaptable for TRU/MTRU waste.

4.3.3. Storage

Historically, contact-handled TRU waste generated at LANL has been placed in interim storage on earth covered storage pads, in pits and trenches, and in storage shafts at TA-54, Area G. Under the TWISP, the contact-handled waste placed on storage pads 1, 2, and 4 will be retrieved and placed in inspectable, RCRA-compliant storage configurations. Other projects for removal of the TRU waste in pits 9 and 29 and trenches A, B, C, and D are being assessed. It is expected that all TRU waste retrieval projects will be initiated and completed within the next 10 years.

Retrieved waste will be placed in storage domes at TA-54 (buildings 48, 153, 224, and 283) that meet all requirements for RCRA container storage. The maximum storage capacity in the existing domes is approximately 11,000 55 gallon drums (LANL 1996). Presently, approximately 7,200 drums are in storage.

Contact handled TRU and mixed TRU waste generated in the future will also be placed in the storage domes discussed above. Based on the timing of shipments to WIPP, new domes may need to be constructed to accommodate the anticipated volume of newly generated waste. Because these are essentially prefabricated buildings, they can be added without significant cost or delay.

Historically, remote-handled TRU and mixed TRU waste have been placed on an interim basis in disposal shafts at Area G since 1970. This practice has continued to the present day. The amount of this remote-handled waste totals about 93 m^3, occupying 60 shafts. All remote-handled TRU and mixed TRU waste generated in the future will be placed in interim storage in shafts.

4.3.4. Disposal

The current DOE and LANL management plan is to ship all TRU waste for disposal at WIPP. Shipments are expected to begin in the spring of 1998, the planned opening of the facility. The rate at which LANL's TRU waste will be shipped to WIPP depends upon the rate at which it can be characterized and certified to meet WIPP Waste Acceptance Criteria. Under the baseline work off plan for LANL TRU and mixed TRU waste (LANL 1996), legacy and newly generated waste will be shipped to WIPP over a 17-year period. An accelerated work off plan calls for shipping the waste to WIPP over an 8.5-year period. The WIPP's disposal capacity is expected to exceed that required to accommodate LANL's TRU waste.

Presently, the only disposal alternative for TRU waste is the WIPP. Given the long history of the WIPP's development, it is unlikely that any other alternatives for TRU Waste disposal will be realized in the next 10 years.

4.4. TRU SWEIS Strategies

Three different TRU Waste management strategies were postulated based on viable CTSD capabilities:

- Current Path.
- Maximum Onsite.
- Minimum Onsite.

Section 4.4.1 presents the viable CTSD options and describes how they are implemented in the three TRU waste strategies. Sections 4.4.2, 4.4.3, and 4.4.4 apply the strategies to the four SWEIS alternatives: No Action, Expanded, Reduced, and Greener. Section 4.4.5 summarizes and compares the three strategies.

4.4.1. Strategies Development and Assumptions

Table 4-7 lists the CTSD options that are applicable to the management of TRU waste generated at LANL over the next 10 years. This list excludes options that are not viable within the 10 year time frame or are not obviously cost effective. Many of the listed options are generalized because of the variety of technologies available or because they are being developed further. Table 4-7 also shows how each of the CTSD options is implemented in the three TRU waste strategies.

The following objectives were identified in formulating the current path TRU waste management strategy and implementing applicable CTSD options:

- Be consistent with current LANL waste management philosophy.
- Consider cost effectiveness and practicality.
- Reflect current TRU waste management practice.
- Take into account that WIPP opens in the spring of 1998.
- Conform with WIPP Waste Acceptance Criteria.
- Prepare waste for disposal at WIPP with minimal processing.
- Consider that LDR treatment is not required.
- These same objectives were set for the Maximum Onsite and Minimum Onsite Strategies, with the following modifications:
- Maximum Onsite—Take into account that LDR treatment must occur on site.
- Minimum Onsite—Take into account that offsite LDR treatment must be used.

In the evaluation of the TRU waste strategies, no credit was taken for volume reduction that can be achieved through size reduction or decontamination. This decision was based on the fact that the volumes of TRU listed in Section 4.2 are based on historical data recorded after the waste had been passed through treatment systems. Applying volume reduction ratios to the process feeds a second time would result in underestimation of the volumes of TRU waste coming out of treatment processes over the next 10 years.

4.4.2. Current Path Strategy

The Current Path TRU waste management strategy was applied to the projected TRU waste treatability group volumes for the four SWEIS alternatives. Process flow diagrams showing the disposition of the TRU waste under this strategy are given in Figures 4-1, 4-2, 4-3, and 4-4 for the SWEIS No Action, Expanded, Reduced, and Greener alternatives, respectively. Table 4-8 summarizes the disposition of LANL's TRU waste inventories in the next 10 years under the Current Path strategy.

4.4.3. Maximum Onsite Strategy

The Maximum Onsite TRU waste management strategy also was applied to the projected TRU waste treatability group volumes for the four SWEIS alternatives. Process flow diagrams showing the disposition of the TRU waste under this strategy are shown in Figures 4-5, 4-6, 4-7, and 4-8 for the SWEIS No Action, Expanded, Reduced, and Greener alternatives, respectively. Table 4-9 summarizes the disposition of LANL's TRU waste in the next 10 years under the Maximum Onsite waste strategy.

4.4.4. Minimum Onsite Strategy

The Minimum Onsite TRU waste management strategy also was applied to the projected TRU Waste treatability group volumes for the four SWEIS alternatives. Process flow diagrams depicting the disposition of the TRU waste under this strategy are given in Figures 4-9, 4-10, 4-11, and 4-12 for the SWEIS No Action, Expanded, Reduced, and Greener alternatives, respectively. Table 4-10 summarizes the disposition of LANL's TRU waste the next 10 years under the Minimum Onsite strategy.

4.5. Strategies Comparison

The results of the three TRU Waste strategies presented in the preceding sections were summarized and compared on the basis of waste throughput for each of the strategy elements: characterization, treatment, storage, and disposal. The volume throughputs for the three postulated TRU Waste strategies are presented in Tables 4-11, 4-12, 4-13, and 4-14 for the four SWEIS No Action, Expanded, Reduced, and Greener Alternatives, respectively.

Because of the limited options for the ultimate disposition of TRU waste in the next 10 years, the results of the three postulated strategies are very similar. The management of TRU waste is also restricted in that volume reduction options such as thermal treatment and compaction are not desirable (due to thermal power limits imposed on the TRU waste packages). In particular, the only difference between the Maximum Onsite strategy and the Minimum Onsite strategy is that one involves LDR treatment of TRU waste on site while the other involves implementing the same treatment off site. Furthermore, the Current Path strategy varies from the other two strategies only in that it omits LDR treatment as a strategy element.

Table 4-1. Total TRU waste inventory in storage by BIR_WS code (as of 12/31/95).

BIR_WS	Volume (m^3)	Waste Description
MTRU Waste		
LA-M1	22.3	Solidified inorganics and organics
LA-M10	2,368.9	Metallic waste
LA-M11	87.4	Glass waste
LA-M12	1,143.9	Noncombustible miscellaneous waste
LA-M14	730.6	Combustible and noncombustible waste
LA-M15	10.4	Hot cell waste
LA-M16	1,122.2	Combustible waste
LA-M17	312.9	Unknown miscellaneous waste
LA-M2	6.0	Absorbed organics on vermiculite
LA-M3	611.1	Cemented process sludge
LA-M4	508.2	Cemented and uncemented inorganics
LA-M6	47.7	Nitrate salts
LA-M8	1,612.2	Homogeneous inorganic solids
LA-M9	0.8	Leaded glovebox gloves
TRU Waste		
LA-T10	3.5	Metallic waste
LA-T11	6.9	Glass waste
LA-T12	74.1	Noncombustible miscellaneous waste
LA-T14	6.4	Combustible and noncombustible waste
LA-T16	61.6	Combustible waste
LA-T4	3.3	Cemented and uncemented inorganics
LA-T5	66.8	Pyrochemical salts
LA-T7	107.9	Soils
LA-T9	5.4	Glovebox gloves
Remote-Handled TRU Waste		
LA-RM14	93.2	Remote-handled mixed waste
“Buried” TRU Waste		
None	2,596	Buried TRU waste
TOTAL	11,610	TOTAL WASTE IN STORAGE AS OF 12/31/95

Table 4-2. Total TRU waste treatability group inventories by SWEIS alternatives.

BIR_WS	No Action	Expanded	Reduced	Greener	Description
Mixed TRU Waste					
LA-M1	49.9	93.4	40.9	50.3	Solidified inorganics and organics
LA-M2	6.5	7.3	6.3	6.5	Absorbed organics on vermiculite
LA-M3	728.1	744.1	728.1	728.2	Cemented process sludge
LA-M4	696.7	993.6	635.4	699.1	Cemented and uncemented inorganics
LA-M6	58.7	76.1	55.1	58.9	Nitrate salts
LA-M8	1,820.2	1,849.0	1,820.1	1,820.2	Homogeneous inorganic solids
LA-M9	1.8	3.4	1.5	1.8	Leaded glovebox gloves
LA-M10	2,578.4	2,866.9	2,518.0	2,582.0	Metallic waste
LA-M11	121.4	161.3	112.7	122.3	Glass waste
LA-M12	1,559.0	2,192.5	1,427.6	1,565.0	Non-combustible miscellaneous waste
LA-M14	1,108.8	1,161.0	1,108.4	1,109.0	Combustible and non-combustible waste
LA-M15	12.8	14.1	12.4	12.9	Hot cell waste
LA-M16	1,562.5	2,154.3	1,436.8	1,572.0	Combustible waste
LA-M17	665.5	1,025.2	591.8	668.4	Unknown miscellaneous waste
TRU Waste					
LA-T4	7.4	13.8	6.1	7.4	Cemented and uncemented inorganics
LA-T5	125.8	218.6	106.6	126.5	Pyrochemical salts
LA-T7	108.1	108.2	108.1	108.1	Soils
LA-T9	12.1	22.6	9.9	12.2	Glovebox gloves
LA-T10	7.1	9.2	6.6	7.3	Metallic waste
LA-T11	15.4	28.9	12.7	15.6	Glass waste
LA-T12	162.7	285.2	136.8	164.5	Non-combustible miscellaneous waste
LA-T14	23.9	26.3	23.9	23.9	Combustible and non-combustible waste
LA-T16	135.9	242.0	113.6	137.2	Combustible waste
Remote-Handled TRU Waste					
LA-RM14	163.8	202.7	153.2	167.5	Remote-handled mixed waste
“Buried” TRU Waste					
None	2,596.0	2,596.0	2,596.0	2,596.0	Buried TRU waste
TOTAL	14,328.5	17,095.7	13,768.6	14,362.8	TOTAL TRU WASTE TO BE MANAGED IN THE NEXT 10 YEARS

Table 4-3. TRU waste characterization capabilities.

System / Status / Description

SYSTEM: Mobile Passive / Active Neutron Interrogation (PAN) System
STATUS: Presently available at LANL
DESCRIPTION:

- Fully mobile system for accurately measuring the quantity of fissionable material in 55-gallon drums.
- Accuracy is enhanced when used in conjunction with the Mobile Segmented/Tomographic Gamma-Scanning System.
- Addresses WIPP Waste Acceptance Criteria requirements for alpha curie content, fissile gram equivalent, Pu-239 equivalent activity, and thermal loading data.
- Additional technology development is needed to address the following:
  - Integrating the results obtained from the various radioassay instruments to arrive at the best estimate of what is contained in a waste container (“physics-based data integration”).
  - Identifying waste drums that are good candidates for repackaging of waste contents into separate TRU waste and LLW portions.
  - Optimizing data acquisition algorithms.
  - Incorporating multiple detectors to minimize the time needed to assay drums with low Pu-content.
  - Indexing tomographic gamma scan and digital radiograph for easy overlay of data and identification of “hot” objects.

SYSTEM: Mobile Segmented / Tomographic Gamma-Scanning System
STATUS: Presently available at LANL
DESCRIPTION:

- Fully mobile system for locating and quantifying gamma and x-ray sources within 55- and 85-gallon waste drums.
- Can determine isotopic ratios of radioactive materials in wastes.
- Characterization accuracy is enhanced when used in conjunction with the PAN system.
- Addresses WIPP Waste Acceptance Criteria requirements for alpha curie content, fissile gram equivalent, Pu-239 equivalent activity, and thermal loading data.

SYSTEM: Mobile Real-Time Radiography System
STATUS: Presently available at LANL
DESCRIPTION:

- Fully mobile real-time and digital radiography system for non-invasive examination of up to 85-gallon waste drums and standard waste boxes.
- Data can be stored on either VCR tape or digitally on a CD or floppy disk.
- Addresses WIPP Waste Acceptance Criteria requirements for packaging and waste form through verification of “knowledge of process” or “acceptable knowledge”.

Table 4-3. Continued.

System / Status / Description

SYSTEM: Pulsed Fast Neutron Analysis / Thermal Neutron Capture
STATUS: Being developed by DOE for MLLW
DESCRIPTION:

- Non-destructive analysis tool to inspect 55-gallon drums containing MLLW.
- Demonstrated ability to produce three-dimensional maps of the distribution of many elements within a closed container.
- Can quantitatively detect the presence of hazardous elements such as Hg and Cl; hazardous compounds such as PCBs may also be determined.
- May be used to address WIPP Waste Acceptance Criteria requirements for RCRA characterization.

SYSTEM: Mobile Drum Venting System (DVS)
STATUS: Presently available at LANL
DESCRIPTION:

- Self-contained automated system to safely vent up to 55-gallon drums.
- Capable of safely containing deflagrations while venting drums with over 30 percent hydrogen gas.
- Can be used for installing filter vents and taking headspace gas samples.
- Addresses WIPP Waste Acceptance Criteria requirements for headspace sampling, volatile organic compounds, and venting.

SYSTEM: Mobile Headspace Gas Sampling
STATUS: Presently available at LANL
DESCRIPTION:

- Takes headspace gas samples from vented drums.
- Addresses WIPP Waste Acceptance Criteria requirements for headspace gas sampling.

SYSTEM: Portable Waste Characterization Glovebox
STATUS: Two gloveboxes are presently available at TA-50-69 (WCRRF)
DESCRIPTION:

- Four-station glovebox for safely opening and examining the contents of waste drums.
- Equipped with internal HEPA filters for inlet and exhaust, air and a sump to contain free liquids from the waste.
- Designed with a drum-handling unit which elevates the waste drum and positions it on its side to facilitate emptying the waste contents into the glovebox.
- Headspace gas sampling is also conducted inside the glovebox.
- Provides limited sorting and repackaging capabilities for waste stored in up to 85-gallon drums.
- Visual characterization can be performed at a rate of two drums per day.
- Addresses WIPP Waste Acceptance Criteria requirements for packaging, waste form, and RCRA characterization.

Table 4-3. Continued.

System / Status / Description

SYSTEM: Portable Drum Coring Glovebox (DCG)
STATUS: Presently available at LANL
DESCRIPTION:

- Enables core sampling of cemented and solidified wastes.
- Consists of a portable glovebox which contains the core-drilling unit.
- Unit is expected to be operational by the end of fiscal year 1996.
- Capacity for processing is one drum per day.
- Addresses WIPP Waste Acceptance Criteria requirements for RCRA characterization.

SYSTEM: Organic Analytical Support
STATUS: Presently conducted at CMR by CST-12
DESCRIPTION:

- Handling of TRU waste is performed in gloveboxes.
- Uses GC/FID, one GC/ECD, and four GC/MS instruments for TRU characterization; all are equipped with auto-samplers.
- Uses a soxhlet extractor and a concentrator unit for TRU waste extraction.
- Supports total volatile organic compounds (VOC) (purgeable and non-purgeable), semivolatile organic compound (SVOC), and PCB analyses.
- Additional support for headspace VOCs, hydrogen, and methane analyses can be provided as on-line or at-line instrumentation.
- Present analytical capacity is for up to 200 samples per year.
- Need to develop new sample preparation and/or instrumentation for waste samples with interfering matrices (e.g., oily, envirostone, or Portland cement waste samples)

SYSTEM: Mobile Organic Analysis System
STATUS: Under development at LANL
DESCRIPTION:

- Consists of a mobile glovebox and analytical system for semi-automated analysis of VOCs and SVOCs in solidified TRU waste.
- Based on EPA method 3545, accelerated solvent extraction of SVOCs and PCBs from solid waste.
- May be possible to use non-RCRA solvents for sample preparation.
- Will be deployed at coring and sampling facilities for onsite analysis.

Table 4-3. Continued.

System / Status / Description

SYSTEM: RCRA Metals Analytical Support
STATUS: Presently conducted at CMR by CST-9
DESCRIPTION:

- Uses conventional analytical methods to characterize three major TRU waste forms, including envirostone, Portland cement, and pyrochemical salt.
- Uses a modified 3051 SW-846 microwave digestion method for dissolving TRU waste samples.
- Uses cold vapor atomic fluorescence spectroscopy for determining Hg.
- Uses inductively coupled plasma atomic emission spectroscopy for determining Ba, Be, Cd, Cr, Ni, Ag, V, and Zn concentrations.
- Uses inductively coupled plasma mass spectroscopy for determining As, Sb, Se, Pb, and Tl concentrations.
- Currently, analysis turn-around takes weeks.
- Concerns regarding the current analytical methods include:
  - High cost.
  - New waste generation resulting from solubilization of the solid matrix.
  - Considerable analytical resources needed to implement the associated Quality Assurance program and shortened operational life of gloveboxes due to the use of highly concentrated acids for sample digestion.
- Potential direct chemical analysis techniques that can address the above concerns and which are suitable for mobile deployment include:
  - Glow discharge mass spectrometry.
  - Laser-induced breakdown spectroscopy.
  - Direct-current (DC) arc atomic emission spectroscopy.
  - Laser ablation inductively coupled plasma mass spectrometry.
  - Energy-dispersive x-ray fluorescence.
- Other promising technologies for improving Transuranic Waste Characterization Program RCRA metals analysis and which are also suitable for mobile deployment include:
  - Isotope dilution inductively coupled plasma mass spectrometry.
  - Capillary electrophoresis.

SYSTEM: Mobile TRU Waste Analytical Laboratory
STATUS: Under development at LANL
DESCRIPTION:

- Provides capability for near real-time RCRA characterization of waste when used in conjunction with DVS, water characterization glovebox, drum-coring glovebox, or headspace gas-sampling systems.
- Addresses WIPP Waste Acceptance Criteria requirements for RCRA characterization.

Table 4-3. Continued.

System / Status / Description

SYSTEM: Gas Generation / Matrix Depletion Project
STATUS: Presently being investigated at LANL
DESCRIPTION:

- Addresses concerns regarding the conservatively established TRUPACT-II thermal limits.
- Proposes to increase the thermal limits of the TRUPACT-II by:
  - Demonstrating that the potential for hydrogen gas generation is much lower than presently assumed.
  - Reducing the concentration of hydrogen in the TRUPACT-II inner containment vessel headspace.
- Currently conducting an investigation based on matrix depletion phenomena to determine realistic, age-dependent G-values (gas generation potential) for hydrogen. The realistic G-values are anticipated to be one order of magnitude lower than the conservative values used for establishing TRUPACT-II thermal limits.
- Concurrently investigating the use of hydrogen getters in reducing the concentration of hydrogen in the TRUPACT-II ICV headspace. The activities involved include:
  - Experimental evaluation of the susceptibility of the hydrogen getter diethyl benzene (1,4-bis(phenylethyl)benzene) to poisoning by volatile organic compounds and other gases anticipated to be present in the headspace.
  - Experimental evaluation and calculation of the capability of diethyl benzene to reduce hydrogen concentrations under realistic transportation conditions.

SYSTEM: Drum Inspection Robotics System
STATUS: Presently being evaluated by DOE at the bench-scale and pilot-scale levels
DESCRIPTION:

- Consists of a mobile robotics base that is capable of self-navigation and collecting visual and range images of each drum. Analysis of the images can lead to detection of rust, dents, streaks, blisters, and tilting conditions on the drums.
- Potentially reduces RCRA drum inspection costs, labor, and worker radiation doses.
- Presently, these three drum inspection robots are being evaluated to identify the best elements for integration into an efficient robotics system:
  - The Intelligent Mobile Sensing System built by Lockheed-Martin Aerospace in Denver, Colorado.
  - The Autonomous Robotics Inspection Experimental System built by South Carolina Universities Research and Education Foundation.
  - The Stored Waste Autonomous Mobile Inspector, created by Savannah River Technology Center and Lawrence Livermore National Laboratories.
- Additionally, a separate image analysis system (the “Automated Baseline Change Detection System” built by Lockheed-Martin Missiles and Space) is also being evaluated in conjunction with the mobile robots.

Table 4-4. TRU waste decontamination capabilities.

System / Status / Waste Streams / Description

SYSTEM: Electrokinetics
STATUS: Pilot-scale development at LANL under a cooperative research and development agreement (CRADA).
WASTE STREAMS:

- Metallic contaminants in soils.

DESCRIPTION:

- Electrokinetics is an in-situ method of remediating soil contaminated with toxic and/or radioactive metals.
- Electrodes are installed horizontally or vertically in contaminated soil. When a direct electric field is applied between the electrodes, the metallic ions in the soil migrate to and become concentrated in the vicinity of the electrodes.
- The soil may be pre-conditioned with an appropriate electrolytic solution (such as a carbonate solution) to obtain the desired electrical conductivity and selective mobility of the ions to be removed.
- The concentrated ions may be removed from the soil by either pumping in and removing electrolytic solutions at the vicinity of the electrodes, by electrolytic deposition on the electrode surface, or by adsorption followed by electrode or sorbent material removal.

SYSTEM: Electrolytic Decontamination
STATUS: Full implementation throughout the DOE complex.
WASTE STREAMS:

- Metallic waste (mostly gloveboxes).

DESCRIPTION:

- Involves removing micron layers of metals from contaminated surfaces and collecting the decontamination products in a wash solution. The process is carried out in specially designed electrolytic cells.
- Similar to electropolishing, except the object to be cleaned is not immersed in an electrolytic solution; rather, a low DC voltage is applied to the object through a suitable electrolyte, such as sodium nitrate, to induce surface chemical reactions. Corroded materials are removed at the anode and placed in solution.
- Plutonium and other by-products are reclaimed from the solution and the electrolyte is recycled.

Table 4-4. Continued.

System / Status / Waste Streams / Description

SYSTEM: Plasma Decontamination
STATUS: Lab-scale development at LANL.
WASTE STREAMS:

- Metallic wastes.

DESCRIPTION:

- Uses a radio frequency discharge in a low-pressure atmosphere of a fluorine bearing gas, such as CF_4 or NF_3. This process induces dissociation of the gas into species that react with plutonium to form the gaseous compound PuF_6.
- A conceptual process using plasma decontamination involves etching away surface Pu-contamination with the reactive gaseous species, trapping the PuF_6 gas on metallic fluorides such as NaF in the recovery system, and processing the decontamination by-products into appropriate forms for disposal.

SYSTEM: Radioactive Sorting
STATUS: Available throughout the DOE complex.
WASTE STREAMS:

- Soils and debris.

DESCRIPTION:

- The segmented gamma spectroscopy method assays and separates uranium and other radioactive contamination from soil matrices using NaI gamma-ray scintillation detectors, count geometry, shielding, and count times.
- The segmented gamma spectroscopy plant consists of a hopper, a conveyor system, radiation detectors, control gate, and computer controls. When the radiation is detected in the waste materials on the conveyor system, the control gate is activated to separate the contaminated portions of the waste.
- Capable of processing as many as 100,000 yd^3 of soil and can achieve volume reduction as high as 98 percent, depending on the extent of contamination.

Table 4-5. Potential LDR Thermal Treatment Capabilities.

System / Status / Waste Streams / Description

SYSTEM: Microwave Solidification
STATUS: Being developed at the Rocky Flats Environmental Technology Site; Bench- and pilot-scale tests have been performed.
WASTE STREAMS:

- Hydroxide coprecipitated sludges; homogeneous, wet or dry inorganic solids; incinerator ash; nitrate salts; solar pond sludge; remediation soils; asbestos; foundry wastes.

DESCRIPTION:

- The process involves the following:
  - Drying the waste.
  - Mixing the waste with a slice source and matrix modifier.
  - Transferring the waste to a processing container.
  - Subjecting the waste mixture to microwave energy to melt the materials (at about 1000 °C).
- The final waste form is a vitreous material that contains no free liquids, has limited releasable particulates, and is highly leach resistant.
- Volume reductions of up to 80 percent are achievable.
- Potential replacement technology for cement stabilization.
- Other benefits of microwave solidification include:
  - Required equipment is inexpensive and easy to maintain.
  - Efficient energy transfer due to direct coupling between the microwave energy and the waste material.
  - The process can be brought to operational temperature in minutes.
  - Waste material is processed directly inside a drum, eliminating cumbersome material transfers.

Table 4-5. Continued.

System / Status / Waste Streams / Description

SYSTEM: Plasma Hearth Process (PHP)

STATUS: Title 1 design of a non-radioactive pilot-scale system has been completed, and a Title II design has been initiated. A Title I radioactive bench-scale smelter system design has been reviewed, and a Title II design has been initiated. The system is being developed as a collaboration between Lockheed Idaho Technologies Company, Argonne National Laboratory-West, Science Applications International Corporation, and Rechtech, Inc.

WASTE STREAMS:

- Wide variety of mixed wastes.

DESCRIPTION:

- PHP uses a direct current arc plasma transferred torch to break complex organic compounds into simpler gases while melting inorganic materials into slag and metal. Actinides and oxidized heavy metals are trapped in the slag phase, which when removed and cooled, solidifies into a glass-like or vitrified state.
- The major components in the PHP include:
  - Waste feed airlock.
  - Plasma chamber.
  - Baghouse to trap generated fly ash.
  - HEPA filter bank.
  - Acid gas scrubber.
  - NO_x abatement system (if required).
  - Stack.
- The benefits of PHP thermal treatment include:
  - High-efficiency destruction of organics.
  - Encapsulation of heavy metals and radionuclides in the final vitrified waste matrix.
  - Maximum volume reduction possible.
  - Low off-gas emissions.
  - Capability to treat many waste types in a single-step process.
- The final production-size PHP system will have a 1.2-MW plasma torch and a throughput of two 55-gallon drums per hour.

Table 4-5. Continued.

System / Status / Waste Streams / Description

SYSTEM: Steam Reforming
STATUS: Technology has been proven commercially on various types of hazardous waste streams by Thermo Chem and Synthetica Technologies
WASTE STREAMS:

- Solvent wastes, aqueous wastes with toxic organic contaminants, paint waste, printing ink, glues, sealants, medical infectious wastes, spent filters, spent adsorbents, loaded activated carbon, pharmaceutical wastes, pesticides, chemical warfare agents, some explosives, printed circuit boards, and other organic materials.

DESCRIPTION:

- The steam reforming system destroys wastes using super-heated steam to strip organic compounds from the waste matrix and passing the gasified organic mixture through the detoxifier chamber. This chamber is electrically heated to 1,200 °C to destroy the organic compounds.
- The system can process up to three drums of waste per day.
- The steam reforming system developed by Synthetica Technologies is suitable for solid, liquid, and gaseous waste streams.
- The detoxifier does not generate SO_x, NO_x, dioxins, or furans because it operates at high temperatures and does not combust the wastes.

SYSTEM: Vitrification
STATUS: Two years of pilot-scale tests have been completed. The Compact Vitrification System is currently being constructed. This project is a collaboration among the Savannah River Site, Clemson University, Oak Ridge National Laboratory, and various private companies.
WASTE STREAMS:

- Inorganic wastes.

DESCRIPTION:

- Vitrification involves converting inorganic wastes into glass. This is accomplished by using the Reactive Additive Stabilization Process, where carefully chosen additives react chemically with potential glass-formers within the waste.
- Two state-of-the-art joule-heated, slurry-fed glass melters are available at the Clemson University Environmental Systems Engineering Department: the EnVitCo Cold Top Melter Furnace, and the Stir Melter Furnace.
- Vitrification is being looked at as a potential replacement technology for the current practice of cementation.
- Vitrification yields higher volume reduction than cementation (which can actually increase final waste volume).
- Vitrification yields final waste forms that have decreased leachability and increased structural stability when compared to cemented waste forms.

Table 4-5. Continued.

System / Status / Waste Streams / Description

SYSTEM: Molten Salt Oxidation
STATUS: Production-scale system available. This system was developed by Rockwell Energy Technology and Engineering Center.
WASTE STREAMS:
- Heterogeneous and homogeneous inorganic solids, combustibles, and organic compounds.

DESCRIPTION:
- Wastes are injected into molten sodium carbonate (Na_2CO_3) at 900°C using a carrier gas such as air. Oxygen in the air provides an oxidizing environment in the melt.
- Wastes fed into the unit can be in solid, slurry, or pure liquid form.
- Wastes are catalytically destroyed using up to 10 wt% Na_2SO_4 as catalyst.
- Acidic gases from waste destruction are converted to sodium chloride (NaCl) by reaction with Na_2CO_3.
- Decomposition of Na_2CO_3 does not occur until well above 1,200 °C.

Table 4-6. Potential LDR non-thermal treatment capabilities.

System / Status / Waste Streams / Description

SYSTEM: Bacterial Decomposition
STATUS: Only a laboratory scale system is available. Collaboration will occur with Brookhaven National Laboratory for expertise concerning nitrate reduction rates.
WASTE STREAMS:

- Aqueous nitrate wastes (near neutral conditions).

DESCRIPTION:

- Involves the use of nitrate-reducing microorganisms. An example is the halophilic bacteria that use nitrate as the electron acceptor in an anaerobic growth process.
- Toxicity studies with actinides have demonstrated considerable resistance to radiation damage.
- Still need to select and develop bacterial systems with the greatest ability to reduce nitrate to N_2 and with the greatest resistance to actinide toxicity.
- Still need to develop a laboratory-scale bioreactor system and instrumentation.

SYSTEM: Biocatalytic Destruction of Nitrate and Nitrite
STATUS: Laboratory-scale. Further development is still needed on the enzyme-based reactor system, particularly to co-immobilize the necessary enzymes onto the electrode surface. Research is being carried out jointly between Argonne National Laboratory and the University of Iowa.
WASTE STREAMS:

- Aqueous nitrate solutions.

DESCRIPTION:

- The overall biocatalytic destruction process uses naturally occurring reductase enzymes to break down nitrate ions in three steps: (1) reduction of nitrate to nitrite, (2) reduction of nitrite to nitrous oxide, and (3) reducation of nitrous oxide to nitrogen. The reduction process requires three separate reductase enzymes, one for each step.
- The use of enzymes enables highly specific catalytic activity to be achieved without additional chemical reagents or production of secondary waste streams.
- Removal of nitrate from aqueous waste streams would reduce costs in the subsequent waste processing steps and would generally increase final waste form performance.

SYSTEM: Catalytic Chemical Oxidation (CCO)
STATUS: The DETOX CCO system developed by Delphi Research, Inc., has been demonstrated at bench-scale. Work is in progress to study the treatment of the spent reaction solution and system integration.
WASTE STREAMS:

- Solid and liquid waste streams containing organic constituents.

DESCRIPTION:

- The basic concept behind CCO involves oxidizing organic constituents in wastes by reaction with oxygen gas or other oxidizing agents in the presence of catalysts.
- The CCO system uses both an iron catalyst and co-catalysts to degrade the organics in a strong acid solution.
- The system is expected to operate at about 150 °C and 70 psig.

Table 4-6. Continued.

System / Status / Waste Streams / Description

SYSTEM: Cementation
STATUS: Currently in practice throughout the DOE complex.
WASTE STREAMS:
- Salts, inorganic oxides, and organic liquids and solids.

DESCRIPTION:
- Involves solidifying wastes in a cement mixture.
- Concerns exist about long-term waste form stability and embrittlement of the cement.

SYSTEM: Direct Chemical Oxidation
STATUS: A bench-scale facility has been constructed and operated.
WASTE STREAMS:
- Combustible organic solids and liquids, including solvents, detergents, oils and greases, charcoal filter media, incinerator chars and graphite, paper, plastics (with the exception of perfluorinated polymers), chloridated and nitrated wastes, and organics immobilized in media such as sludges.

DESCRIPTION:
- Direct chemical oxidation technology provides oxidative destruction of organic solids or liquids under low temperature and ambient pressure conditions.
- The direct chemical oxidation process uses acidified ammonium peroxydisulfate solutions, and does not require any toxic, expensive, or consumable catalysts.
- The use of peroxydisulfate does not produce any secondary wastes because the reaction product ammonium sulfate, can be recycled by electrolysis.
- A process is being developed that injects peroxydisulfate into water-entrained wastes in a plugflow reactor.

SYSTEM: Evaporation
STATUS: Full implementation throughout the DOE complex.
WASTE STREAMS:
- Wastes containing volatile organic compounds.

DESCRIPTION:
- Evaporation is the process by which volatile organic compounds are removed from the waste through vacuum distillation.

Table 4-6. Continued.

System / Status / Waste Streams / Description

SYSTEM: Freeze Crystallization Technology
STATUS: Bench-scale studies are being conducted by the Idaho National Engineering Laboratory and Rust Clemson Technical Center. Laboratory-scale and bench-scale tests have also been performed by Wheelabrator HPD, Inc. Engineering evaluation was performed by J.L. Hymphrey and Associates.
WASTE STREAMS:

- Evaporator bottoms; aqueous waste containing inorganics, organics, heavy metals, and radionuclide constituents.

DESCRIPTION:

- Freeze crystallization technology is capable of separating organic and inorganic contaminants in an aqueous waste stream by removing the bulk of the water as ice, and concentrating the contaminants in the remaining brine.
- Freeze crystallization is complex, requiring several unit operations, and has high capital and electrical operating costs. However, it may be suitable for waste streams with high (less than 25 percent) dissolved solids and organics content that cannot be handled by membrane or evaporation technology.

SYSTEM: Freeze Drying
STATUS: Laboratory-scale development is being performed by LANL by means of a CRADA.
WASTE STREAMS:

- Non-compactible plastic materials; glovebox gloves; HYDREX filters from liquid waste lines.

DESCRIPTION:

- Freeze drying process involves freezing plastic materials in liquid nitrogen, followed by crushing (or chipping for HYDREX filters) and granulation using conventional mechanical devices.
- Experience at TA-55 at LANL shows that freeze drying can achieve volume reduction ranging from 75-90 percent.
- LANL is proposing to implement freeze drying at TA-35 for TRU waste and MLLW using a liquid nitrogen system to cryogenically freeze plastic wastes and a crusher to reduce the waste volume.

Table 4-6. Continued.

System / Status / Waste Streams / Description

SYSTEM: Hydrothermal Oxidation
STATUS: Design, National Environmental Policy Act (NEPA) documentation, and safety documentation for the Hazardous Waste Pilot Plant have been completed. The plant is a demonstration project focused on identifying hydrothermal oxidation technology development needs and is aimed at providing the basis for the development of the Mixed Waste Pilot Plant.
WASTE STREAMS:

- Spent solvents, oils and other organic liquids, aqueous liquids, sewage and organic laden sludges, spent carbon, solvent contaminated rags, and explosives and energetics.

DESCRIPTION:

- Hydrothermal oxidation involves bringing together organic waste, water, and an oxidant (e.g., air or oxygen) to temperatures and pressures above the critical point of water (374 °C, 22.1 MPa).
- Hydrothermal oxidation can achieve an organic destruction efficiency as high as 99.99 percent.
- The resulting effluent from hydrothermal oxidation is water and carbon dioxide.

SYSTEM: Leaching
STATUS: Currently being practiced throughout the DOE complex.
WASTE STREAMS:

- All waste streams.

DESCRIPTION:

- Leaching is the process by which contaminants are removed from the host medium by the dissolving action of appropriate reagent solutions. The solubilized contaminants are then extracted from the dissolving medium using various techniques, such as ion exchange or membrane separation.
- The reagents used in leaching processes depend on the specific contaminant, but most often include chelating agents such as carbonates, ascorbic acid, siderophorees (microbial iron chelators), and polymeric chelators.

Table 4-6. Continued.

System / Status / Waste Streams / Description

SYSTEM: Low-Temperature Thermal Desorption (LTTD)
STATUS: LTTD technology is being demonstrated at the Rocky Flats Environmental Technology Site using the VAC*TRAX unit developed by Rust Federal Services. The related non-thermal plasma (NTP) gas treatment system is being developed by LANL.
WASTE STREAMS:

- Organic and mercury contaminated solids.

DESCRIPTION:

- LTTD is the process by which hazardous contaminants are desorbed and separated from the waste matrix by heating the materials to no greater than 120 °C.
- The existing process being demonstrated at Rocky Flats involves the following:
  - The waste is prepared and sized in a chilled environment to control the volatilization of the organic contaminants and to more accurately determine the separation efficiency of the process.
  - The waste is loaded into an indirectly heated vacuum dryer equipped with agitator vanes.
  - Heated nitrogen gas is injected into the dryer and blankets the waste as it is agitated and brought to operating temperatures.
  - The waste is then subjected to a vacuum for a predetermined period, allowing time for organic vapors to be driven off.
  - Volatilized organic vapors are either condensed and collected as liquids or are destroyed by passing the gas stream through an NTP gas treatment system.
- The NTP reaction cells use electrical micro-discharges to break up organic molecules.
- The byproducts of the LTTD/NTP process include decontaminated solids, organic condensate, and nitrogen-rich vapor.
- The vapor stream from the LTTD/NTP process is further cleansed using a HEPA filter and a granular activated charcoal adsorption system prior to venting to the atmosphere.

SYSTEM: Magnetic Separation
STATUS: Pilot-scale studies are being conducted by LANL under a CRADA.
WASTE STREAMS:

- Sand, slag, and crucibles.

DESCRIPTION:

- Magnetic separation is a physical separation process that exploits the differences in magnetic susceptibility.
- High-gradient magnetic separation can be applied to selectively extract actinide contaminants from soils, clays and silts.
- High-gradient magnetic separation technology is capable of extracting and concentrating radioactive components from solid, liquid, or gaseous waste streams with minimal pre-treatment.

Table 4-6. Continued.

System / Status / Waste Streams / Description

SYSTEM: Phosphate-Bonded Ceramic Stabilization
STATUS: Research is being performed by Argonne National Laboratory in collaboration with the Center for Advanced Cement-Based Materials at the University of Illinois, Urbana-Champaign, and the University of Dayton Research Institute.
WASTE STREAMS:

- Wastes containing liquid mercury, mercury-contaminated aqueous liquids, toxic and heavy-metal-containing materials, salt cakes, processing salts, beryllium wastes, and pyrophorics.

DESCRIPTION:

- Some advantages of using chemically bonded phosphate ceramics to stabilize or encapsulate waste include:
  - Phosphates are natural analogs of radioactive rare-earth elements and form solid solutions with actinides and rare earths.
  - Phosphates are extremely insoluble.
  - Phosphate-bonded ceramics are non-flammable inorganic polymers.
  - Phosphate-bonded ceramics are pore free, insoluble in groundwater, and stable at elevated temperatures.
  - Phosphates can be processed into a solid cement form at room temperature.
  - Low-temperature synthesis of final waste forms minimizes risks of volatilizing of organics.
  - The process involves minimal generation of secondary waste streams.
  - Overall processing costs are low.
- Surrogate ash waste streams, salt compositions, and cemented sludge have been incorporated in phosphate ceramics with loadings up to 50 percent.

SYSTEM: Polymer Encapsulation
STATUS: Pilot-scale studies and an integrated system demonstration are being conducted to obtain the operational data and design criteria necessary to implement a polymer solidification system. Technology is being developed at Rocky Flats Environmental Technology Site and Brookhaven National Laboratory.
WASTE STREAMS:

- Salts and inorganic oxides; sludges and soils.

DESCRIPTION:

- Polymer encapsulation of mixed wastes encloses waste products in thermoplastic or thermosetting materials using commercially available processing technologies.
- Two primary processes are being tested by DOE: micro-encapsulation and macro-encapsulation.
- In the micro-encapsulation process, thermoplastic polymers such as polyethylene are combined with dried waste in a commercially available extruder, which melts the polymer and mixes it with the waste. The encapsulated waste is extruded in a drum, where it solidifies upon cooling.
- The micro-encapsulation process operates at low temperatures, requires no off-gas treatment, and generates no secondary waste.
- In the macro-encapsulation process, bulk materials such as lead and debris are placed in a drum and encapsulated with molten or liquid plastic.
- Polyethylene encapsulation of nitrate salt waste compares favorably, both economically and technically, against Portland cement grout solidification.

Table 4-6. Continued.

System / Status / Waste Streams / Description

SYSTEM: Pre-treatment for Mercury Removal

STATUS: Several conceptual process flowsheets for the mercury leaching/capture process have been drafted. The project involves researchers at Oak Ridge National Laboratory, 3M Corporation, Nucon International, and General Electric Corporation.

WASTE STREAMS:

- Mercury contaminated solid and liquid wastes, including storm sewer sediments, crushed fluorescent tubes and lamps, ICPP sodium-bearing acid waste, and various leach solutions.

DESCRIPTION:

- Because volatilized mercury is not easily captured in most off-gas treatment systems, pre-treatment to remove mercury from wastes may be necessary if the waste is to be treated thermally.
- Two appropriate methods for removal of mercury from solid waste matrices are (1) acid leaching and (2) GE KI/I_2 leaching.
- Two methods for removing mercury from liquid waste matrices are (1) passing it through sulfur-impregnated activated carbon and (2) subjecting it to the ion-exchange/membrane separation process.

SYSTEM: Supercritical Carbon Dioxide Extraction

STATUS: Laboratory-scale tests are being conducted at the Rocky Flats Environmental Technology Site and the University of Colorado.

WASTE STREAMS:

- Organic-contaminated solid wastes.

DESCRIPTION:

- Supercritical carbon dioxide extraction uses the ability of carbon dioxide to dissolve organic contaminants when it is compressed above 90 °F and 1,080 psig.
- Supercritical carbon dioxide is used to dissolve organic constituents and extract them from the waste substrate. The contaminants can then be precipitated out of the supercritical solution by lowering the temperature and pressure of the confining vessel. The carbon dioxide is then recycled for additional extraction.
- By removing the organic contaminants, the mixed waste can be reclassified as either LLW or TRU waste and be managed as such.

SYSTEM: VAC*TRAXÔ Process for Treatment of PCB Waste

STATUS: A treatability demonstration is being conducted by the Savannah River Site and Rust Clemson Technical Center, Inc.

WASTE STREAMS:

- PCB-contaminated solids.

DESCRIPTION:

- The VAC*TRAXÔ process was found to be most suitable for treating radioactive-PCB porous solid waste.

Table 4-7. Implementation matrix for TRU waste CTSD options versus strategy models.

CTSD Capability	Current Path	Maximum On site	Minimum On site
Characterization			
Acceptable knowledge	Generator function	Generator function	Generator function
Sampling and analysis Nondestructive analysis/ Nondestructive examination Drum headspace sampling Visual inspection of contents Core sampling Organics analysis RCRA metals analysis	Centralized on site	Centralized on site	Centralized on site
Treatment			
Drum preparation	Centralized on site	Centralized on site	Centralized on site
Overpacking	Centralized on site	Centralized on site	Centralized on site
Drum venting	Centralized on site	Centralized on site	Centralized on site
Size reduction	Centralized on site	Centralized on site	Centralized on site
Decontamination	Centralized on site	Centralized on site	Centralized on site
Compaction	Not implemented	Not implemented	Not implemented
Incineration	Not implemented	Not implemented	Not implemented
Repackaging	Centralized on site	Centralized on site	Centralized on site
Special-case treatment	Centralized on site	Centralized on site	Centralized on site
LDR treatment	Not implemented	Not implemented	Not implemented
Storage			
Onsite interim storage Area G RCRA domes Area G shafts TA-55 permitted storage	Used	Used	Used
Disposal			
Waste Isolation Pilot Plant	Used	Used	Used

Table 4-8. Composite disposition of TRU waste inventories under the Current Path strategy.

SWEIS Alternative	Projected Volume (m^3)	Characterization/ Treatment Throughput (m^3)		Storage/Disposal Throughput (m^3)	
No Action	14,329	2,585	Size reduction/ decontamination	Interim Storage	
				164	Area G shafts
		666	Special-case treatment	11,569	Area G domes/ TA-55
		--	LDR treatment (onsite)		
		--	LDR treatment (offsite)	Disposal	
		11,733	WIPP WAC treatment and characterization	11,773	Waste Isolation Pilot Plant
		2,596	No characterization/ treatment	2,596	Area G shafts and trenches (buried waste)
Expanded	17,096	2,876	Size reduction/ decontamination	Interim Storage	
				203	Area G shafts
		1,025	Special-case treatment	14,297	Area G domes/ TA-55
		--	LDR treatment (onsite)		
		--	LDR treatment (offsite)	Disposal	
		14,500	WIPP WAC treatment and characterization	14,500	Waste Isolation Pilot Plant
		2,596	No characterization/ treatment	2,596	Area G Shafts and trenches (buried waste)
Reduced	13,769	2,525	Size reduction/ decontamination	Interim Storage	
				153	Area G shafts
		592	Special-case treatment	11,020	Area G domes/ TA-55
		--	LDR treatment (onsite)		
		--	LDR treatment (offsite)	Disposal	
		11,173	WIPP WAC treatment and characterization	11,173	Waste Isolation Pilot Plant
		2,596	No characterization/ treatment	2,596	Area G shafts and trenches (buried waste)
Greener	14,363	2,589	Size reduction/ decontamination	Interim Storage	
				168	Area G shafts
		668	Special-case treatment	11,598	Area G domes/ TA-55
		--	LDR treatment (onsite)		
		--	LDR treatment (offsite)	Disposal	
		11,766	WIPP WAC treatment and characterization	11,766	Waste Isolation Pilot Plant
		2,596	No characterization/ treatment	2,596	Area G shafts and trenches (buried waste)

Table 4-9. Composite disposition of TRU waste inventories under the Maximum Onsite strategy.

SWEIS Alternative	Project Volume (m^3)	Characterization/ Treatment Throughput (m^3)		Storage/Disposal Throughput (m^3)	
No Action	14,329	2,583	Size reduction/ decontamination	Interim Storage	
				164	Area G shafts
		666	Special-case treatment	11,569	Area G domes / TA-55
		11,135	LDR treatment (onsite)	Disposal	
		--	LDR treatment (offsite)	11,733	Waste Isolation Pilot Plant
		11,733	WIPP WAC treatment and characterization	2,596	Area G Shafts and trenches (buried waste)
		2,596	No characterization/treatment		
Expanded	17,096	2,876	Size reduction/ decontamination	Interim Storage	
				203	Area G shafts
		1,025	Special-case treatment	14,297	Area G domes / TA-55
		13,545	LDR treatment (onsite)	Disposal	
		--	LDR treatment (offsite)	14,500	Waste Isolation Pilot Plant
		14,500	WIPP WAC treatment and characterization	2,596	Area G Shafts and trenches (buried waste)
		2,596	No characterization/treatment		
Reduced	13,769	2,525	Size reduction/ decontamination	Interim Storage	
				153	Area G shafts
		592	Special-case treatment	11,020	Area G domes / TA-55
		10,648	LDR treatment (onsite)	Disposal	
		--	LDR treatment (offsite)	11,173	Waste Isolation Pilot Plant
		11,173	WIPP WAC treatment and characterization	2,596	Area G Shafts and trenches (buried waste)
		2,596	No characterization/treatment		
Greener	14,363	2,589	Size reduction/ decontamination	Interim Storage	
				168	Area G shafts
		668	Special-case treatment	11,598	Area G domes / TA-55
		11,164	LDR treatment (onsite)	Disposal	
		--	LDR treatment (offsite)	11,766	Waste Isolation Pilot Plant
		11,766	WIPP WAC treatment and characterization	2,596	Area G shafts and trenches (buried waste)
		2,596	No characterization/treatment		

Table 4-10. Composite disposition of TRU waste inventories under the Minimum Onsite strategy.

SWEIS Alternative	Project Volume (m^3)	Characterization/Treatment Throughput (m^3)		Storage/Disposal Throughput (m^3)	
No Action	14,329	2,585	Size reduction/ decontamination	<u>Interim Storage</u>	
		666	Special-case treatment	164	Area G shafts
		--	LDR treatment (onsite)	11,569	Area G domes/TA-55
		11,135	LDR treatment (offsite)	<u>Disposal</u>	
		11,733	WIPP WAC treatment and characterization	11,733	Waste Isolation Pilot Plant
		2,596	No characterization/ treatment	2,596	Area G shafts and trenches (buried waste)
Expanded	17,096	2,876	Size reduction/ decontamination	<u>Interim Storage</u>	
		1,025	Special-case treatment	203	Area G shafts
		--	LDR treatment (onsite)	14,297	Area G domes/TA-55
		13,545	LDR treatment (offsite)	<u>Disposal</u>	
		14,500	WIPP WAC treatment and characterization	14,500	Waste Isolation Pilot Plant
		2,596	No characterization/ treatment	2,596	Area G shafts and trenches (buried waste)
Reduced	13,769	2,525	Size reduction/ decontamination	<u>Interim Storage</u>	
		592	Special-case treatment	153	Area G shafts
		--	LDR treatment (onsite)	11,020	Area G domes/TA-55
		10,648	LDR treatment (offsite)	<u>Disposal</u>	
		11,173	WIPP WAC treatment and characterization	11,173	Waste Isolation Pilot Plant
		2,596	No characterization/ treatment	2,596	Area G shafts and trenches (buried waste)
Greener	14,363	2,589	Size reduction/ decontamination	<u>Interim Storage</u>	
		668	Special-case treatment	168	Area G shafts
		--	LDR treatment (onsite)	11,598	Area G domes/TA-55
		11,164	LDR treatment (offsite)	<u>Disposal</u>	
		11,766	WIPP WAC treatment and characterization	11,766	Waste Isolation Pilot Plant
		2,596	No characterization/ treatment	2,596	Area G shafts and trenches (buried waste)

Table 4-11. Waste flows for the three TRU waste strategies applied to No Action TRU waste volumes.

Strategy Elements	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	11,733	11,733	11,733
Treatment			
Onsite WIPP WAC Treatment	11,733	11,733	11,733
Onsite LDR treatment	--	11,135	--
Offsite LDR treatment	--	--	11,135
No treatment	2,596	2,596	2,596
Storage			
Area G shafts	164	164	164
Area G domes / TA-55	11,569	11,569	11,569
Disposal			
WIPP	11,733	11,733	11,733
Area G shafts and trenches (buried waste)	2,596	2,596	2,596

Table 4-12. Waste flows for the three TRU waste strategies applied to Expanded TRU waste volumes.

Strategy Elements	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	14,500	14,500	14,500
Treatment			
Onsite WIPP WAC Treatment	14,500	14,500	14,500
Onsite LDR treatment	--	13,192	--
Offsite LDR treatment	--	--	13,192
No treatment	2,596	2,596	2,596
Storage			
Area G shafts	203	203	203
Area G domes / TA-55	14,297	14,297	14,297
Disposal			
WIPP	14,139	14,500	14,500
Area G shafts and trenches (buried waste)	2,596	2,596	2,596

Table 4-13. Waste flows for the three TRU waste strategies applied to Reduced TRU waste volumes.

Strategy Elements	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	11,173	11,173	11,173
Treatment			
Onsite WIPP WAC Treatment	11,173	11,173	11,173
Onsite LDR treatment	--	10,648	--
Offsite LDR treatment	--	--	10,648
No treatment	2,596	2,596	2,596
Storage			
Area G shafts	153	153	153
Area G domes / TA-55	11,020	11,020	11,020
Disposal			
WIPP	11,173	11,173	11,173
Area G shafts and trenches (buried waste)	2,596	2,596	2,596

Table 4-14. Waste flows for the three TRU waste strategies applied to Greener TRU waste volumes.

Strategy Elements	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	11,766	11,766	11,766
Treatment			
Onsite WIPP WAC Treatment	11,766	11,766	11,766
Onsite LDR treatment	--	11,164	--
Offsite LDR treatment	--	--	11,164
No treatment	2,596	2,596	2,596
Storage			
Area G shafts	168	168	168
Area G domes / TA-55	11,598	11,598	11,598
Disposal			
WIPP	11,766	11,766	11,766
Area G shafts and trenches (buried Waste)	2,596	2,596	2,596

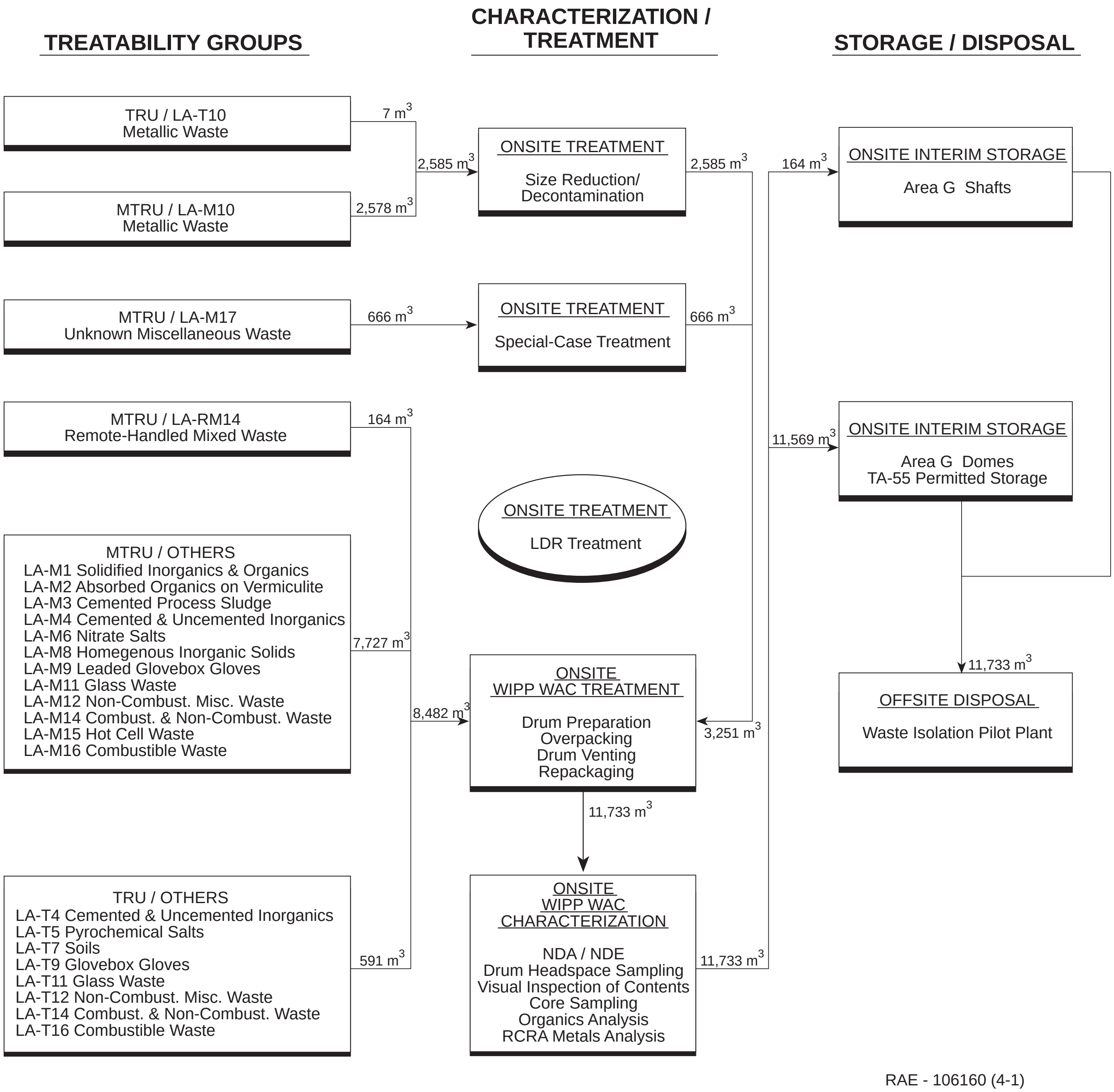

Figure 4-1. Current Path Strategy for No Action TRU Waste Volumes.

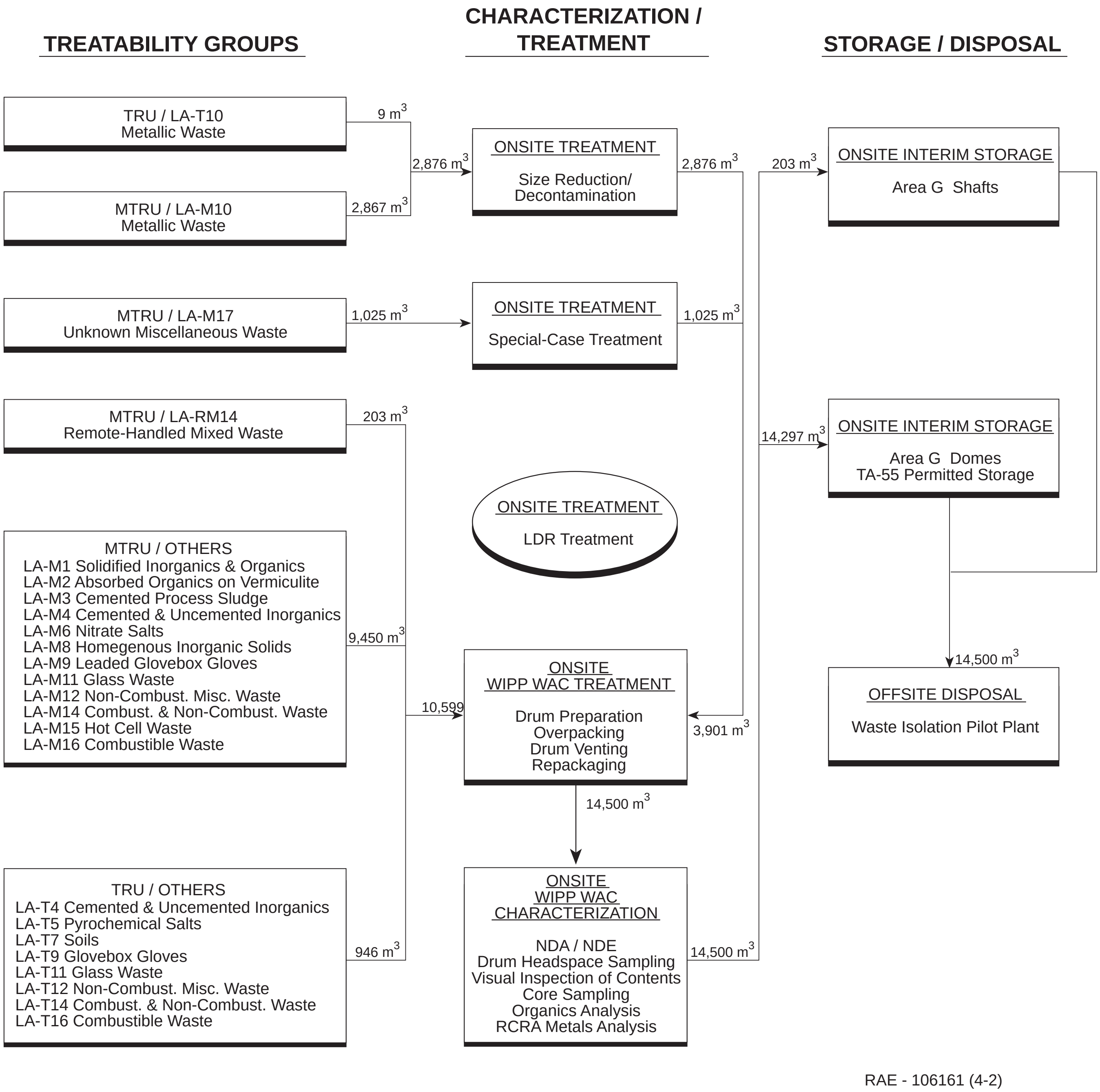

Figure 4-2. Current Path Strategy for Expanded TRU Waste Volumes.

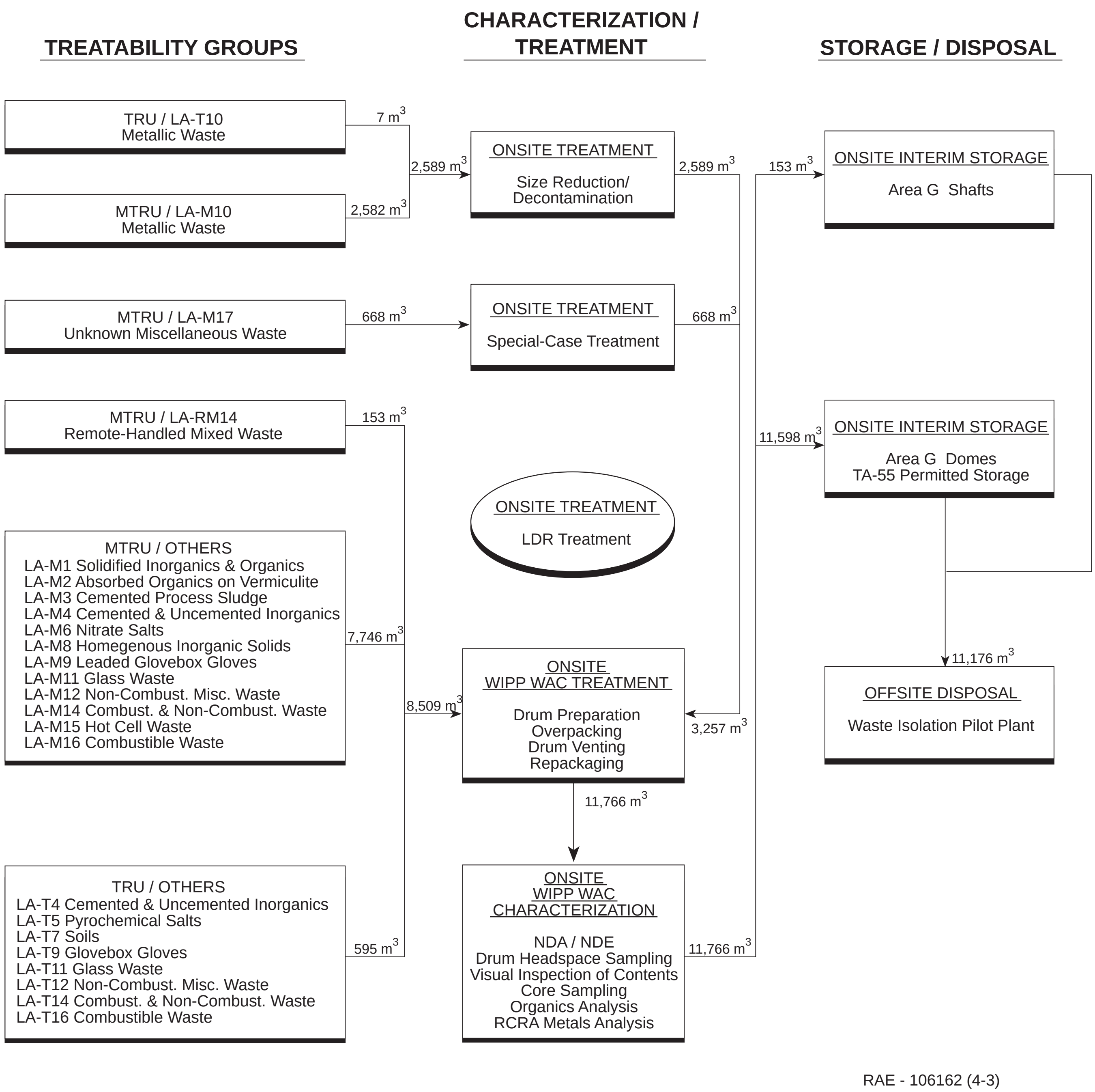

Figure 4-3. Current Path Strategy for Reduced TRU Waste Volumes.

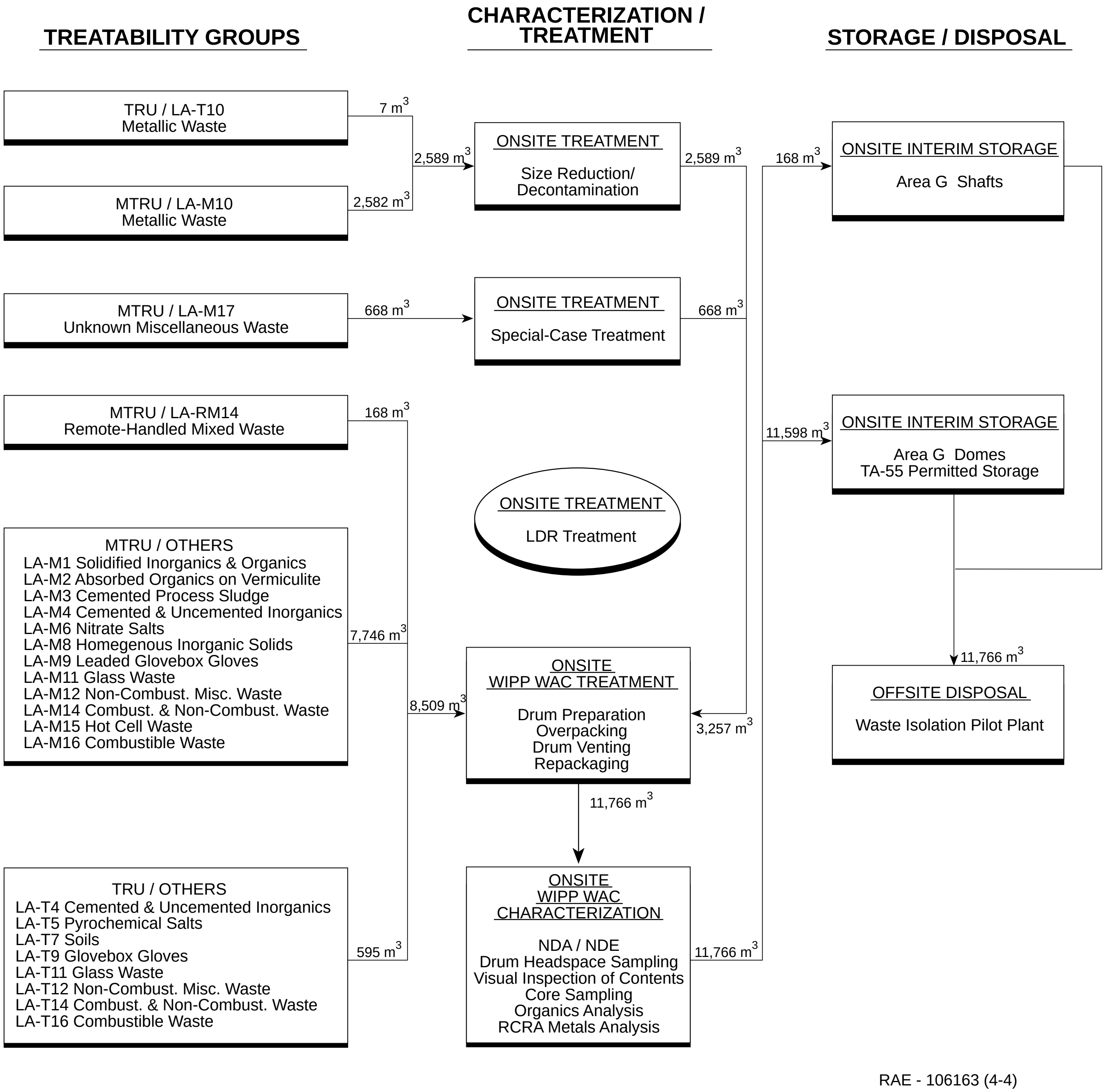

Figure 4-4. Current Path Strategy for Greener TRU Waste Volumes.

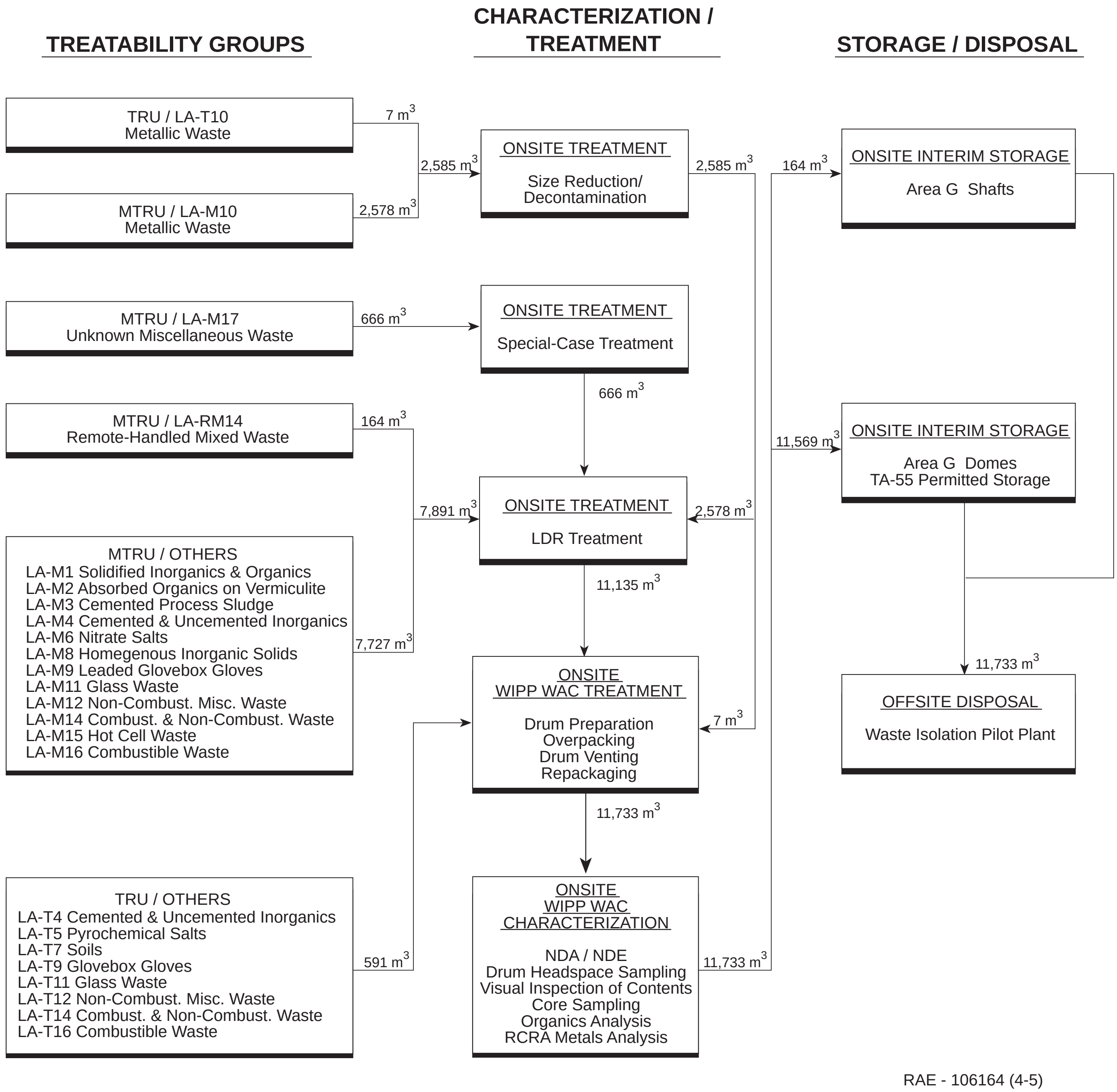

Figure 4-5. Maximum Onsite Strategy for No Action TRU Waste Volumes.

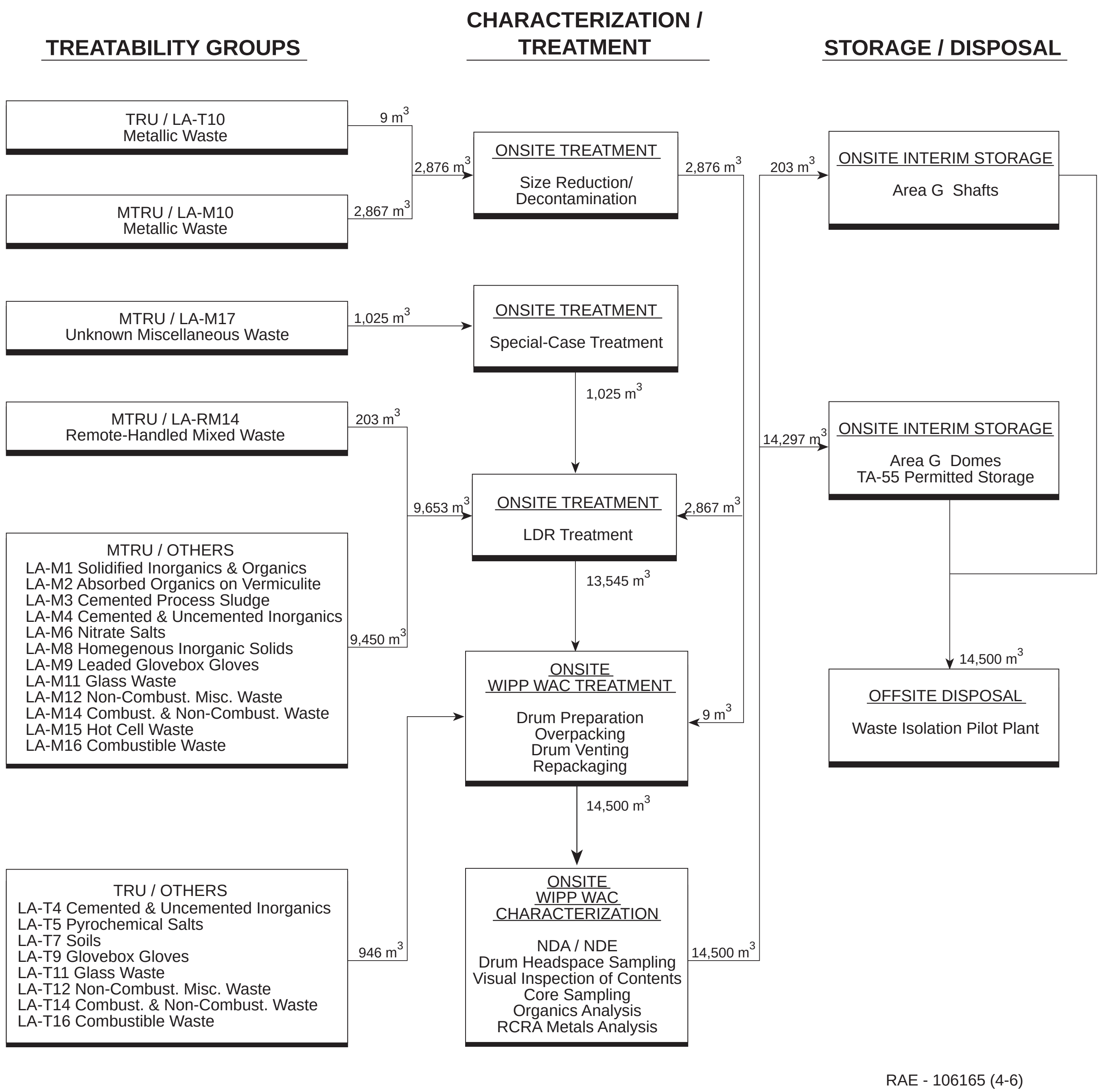

Figure 4-6. Maximum Onsite Strategy for Expanded TRU Waste Volumes.

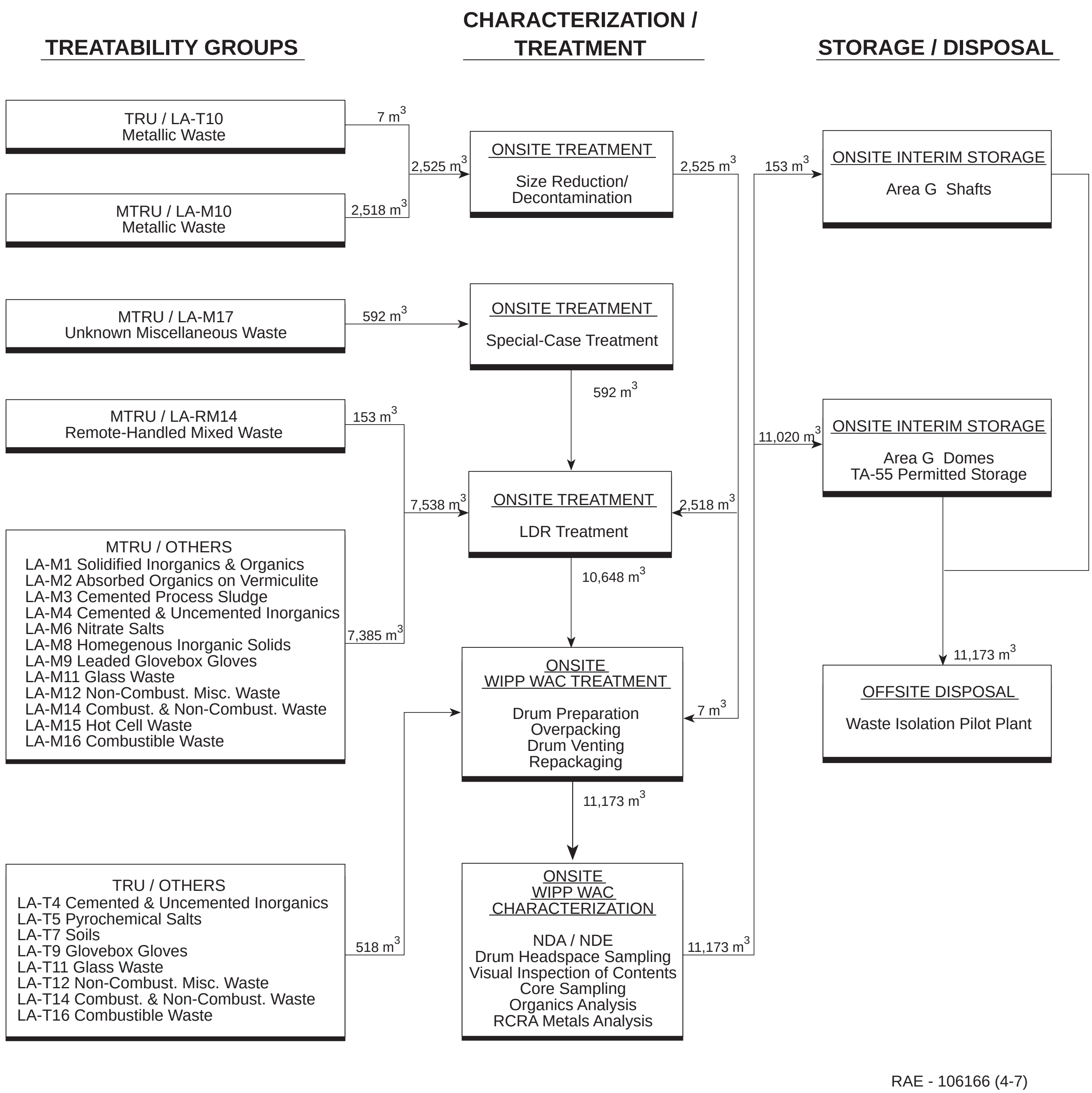

Figure 4-7. Maximum Onsite Strategy for Reduced TRU Waste Volumes.

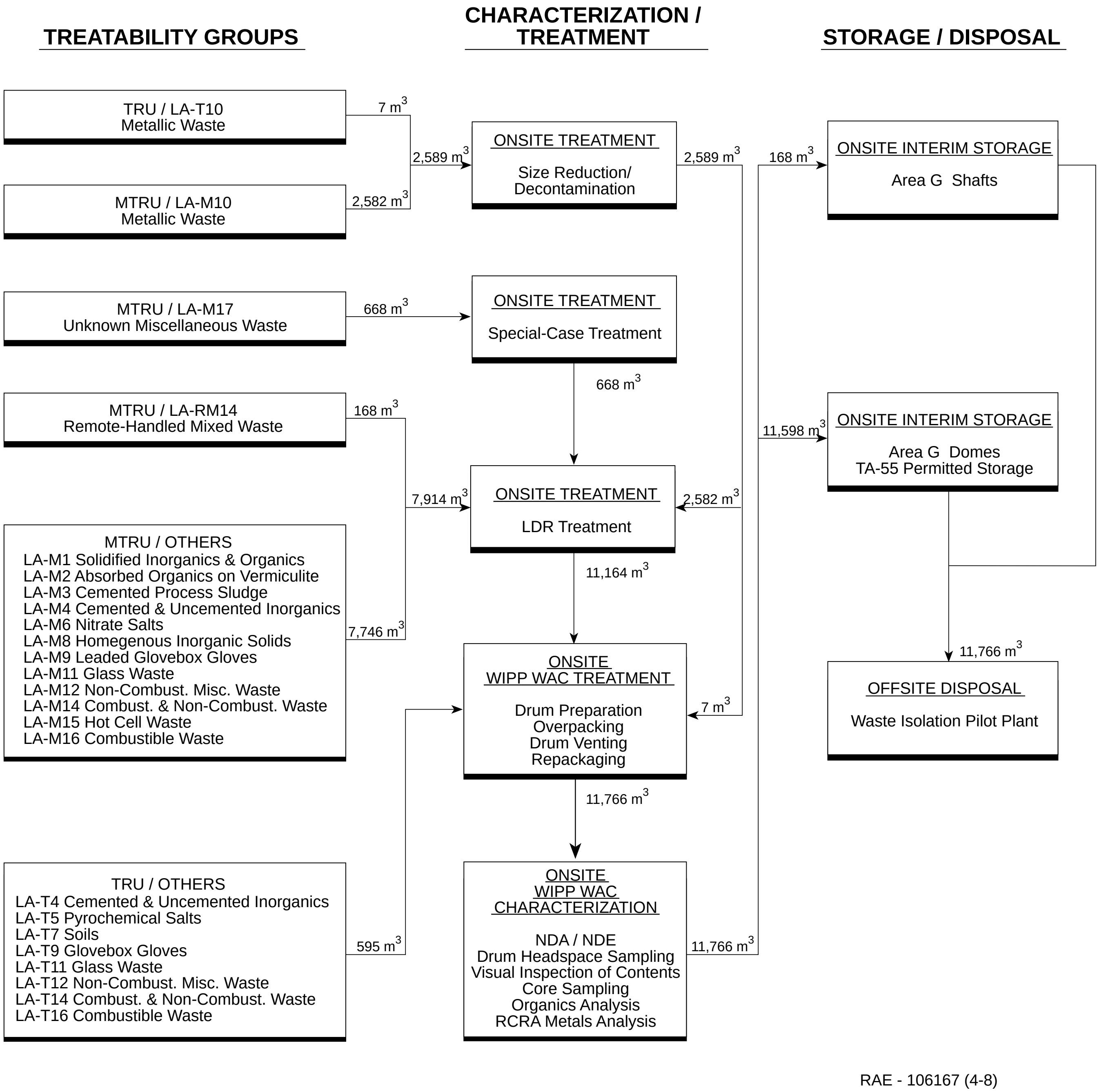

Figure 4-8. Maximum Onsite Strategy for Greener TRU Waste Volumes.

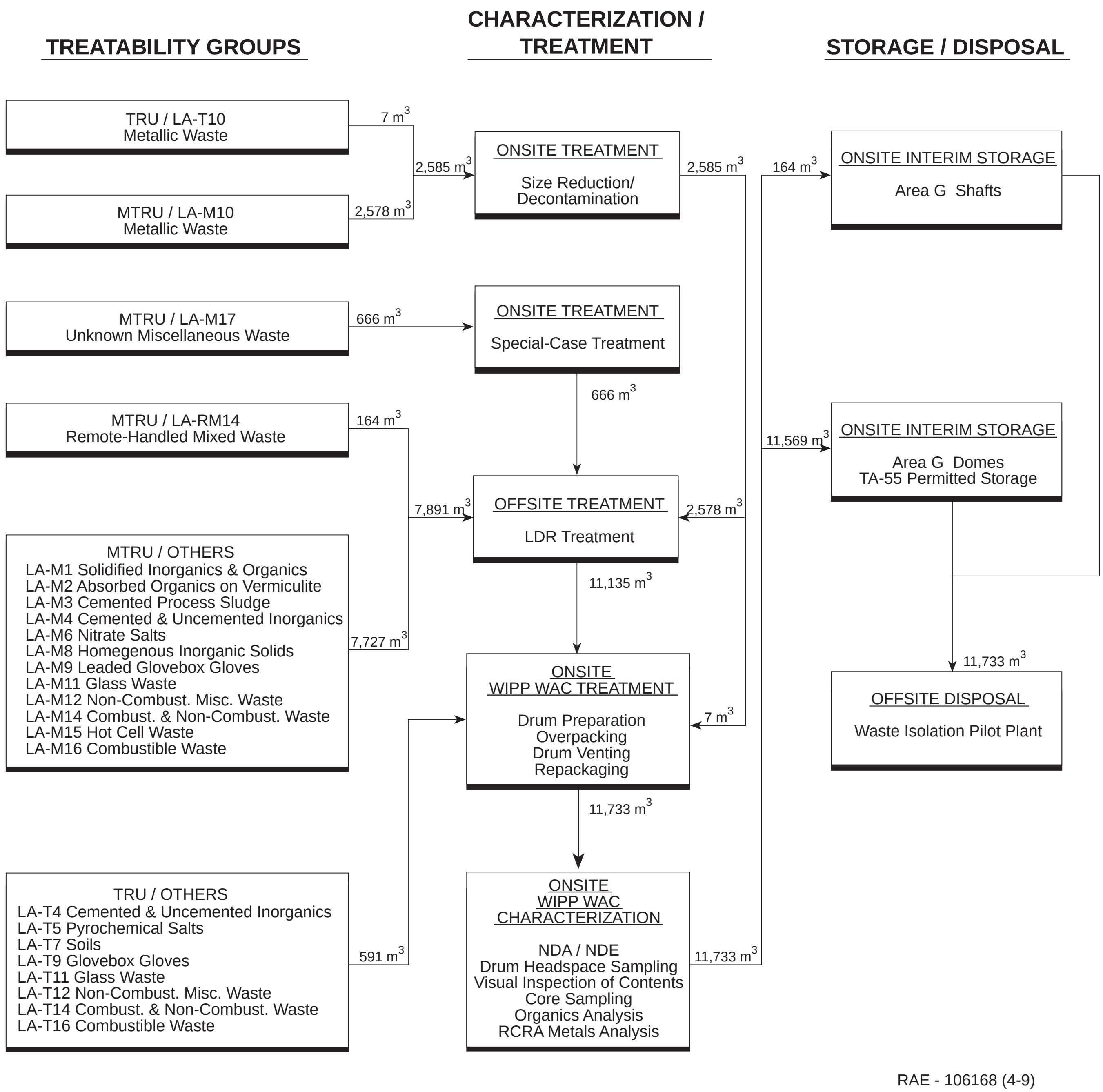

Figure 4-9. Minimum Onsite Strategy for No Action TRU Waste Volumes.

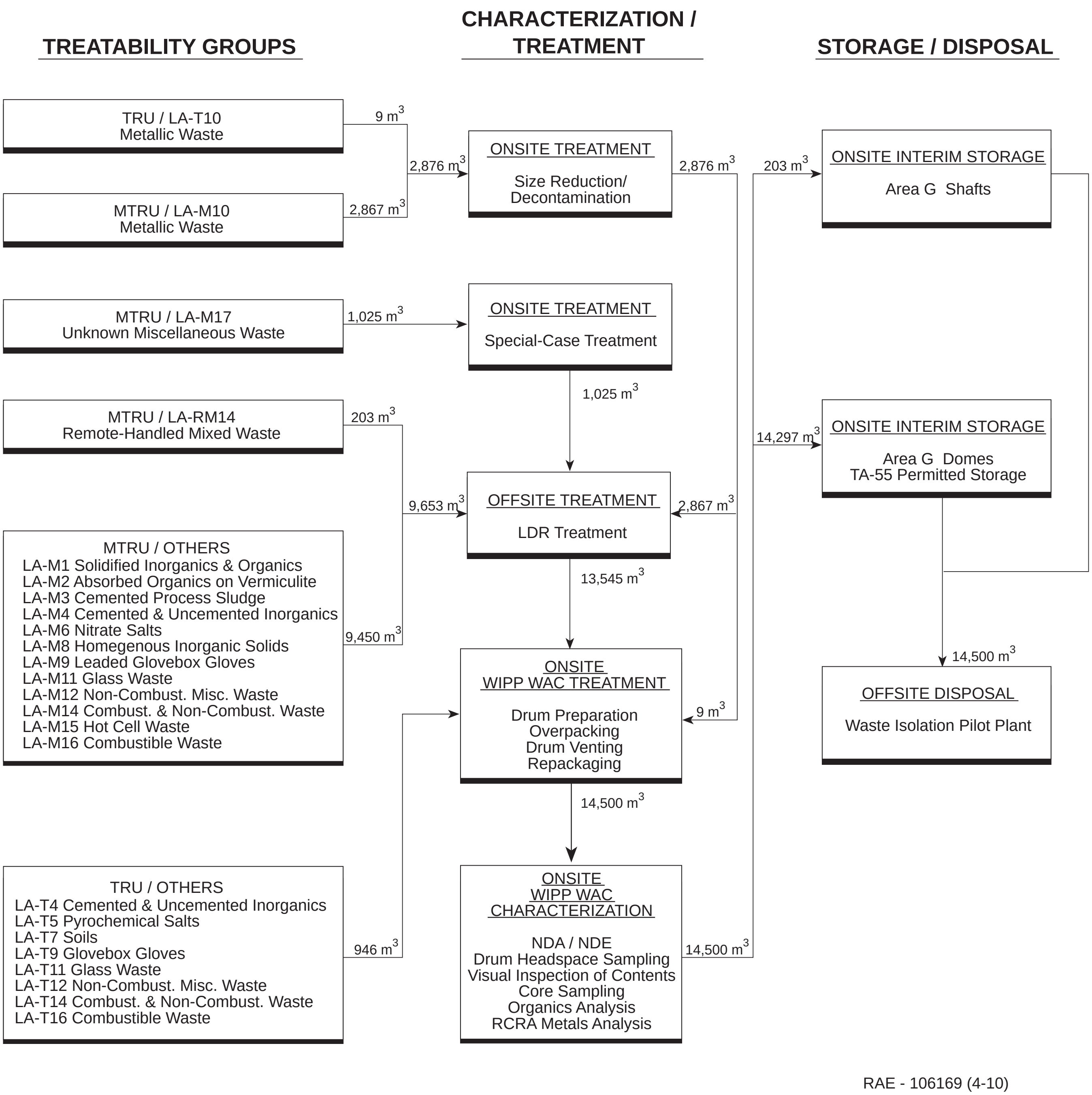

Figure 4-10. Minimum Onsite Strategy for Expanded TRU Waste Volumes.

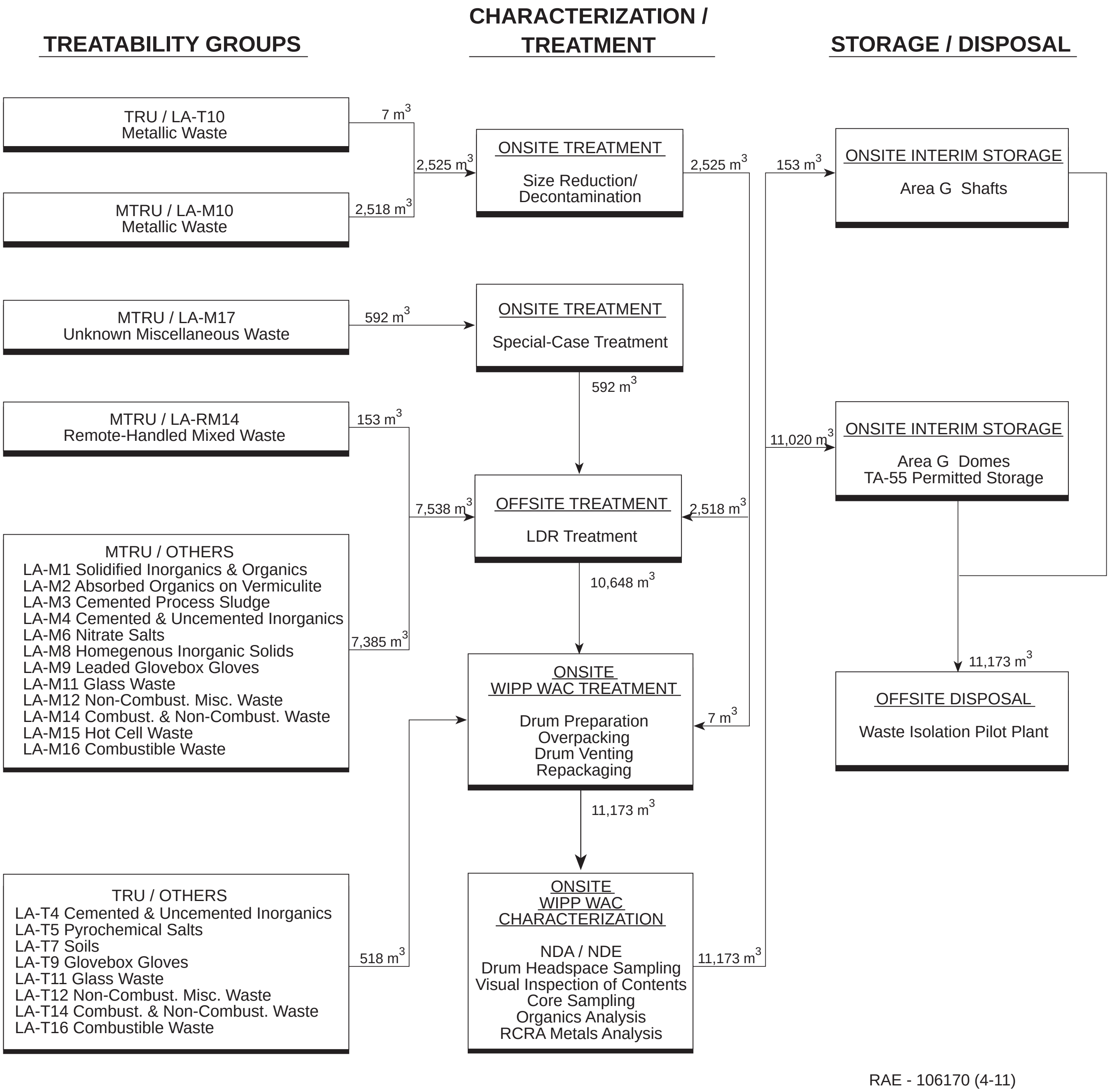

Figure 4-11. Minimum Onsite Strategy for Reduced TRU Waste Volumes.

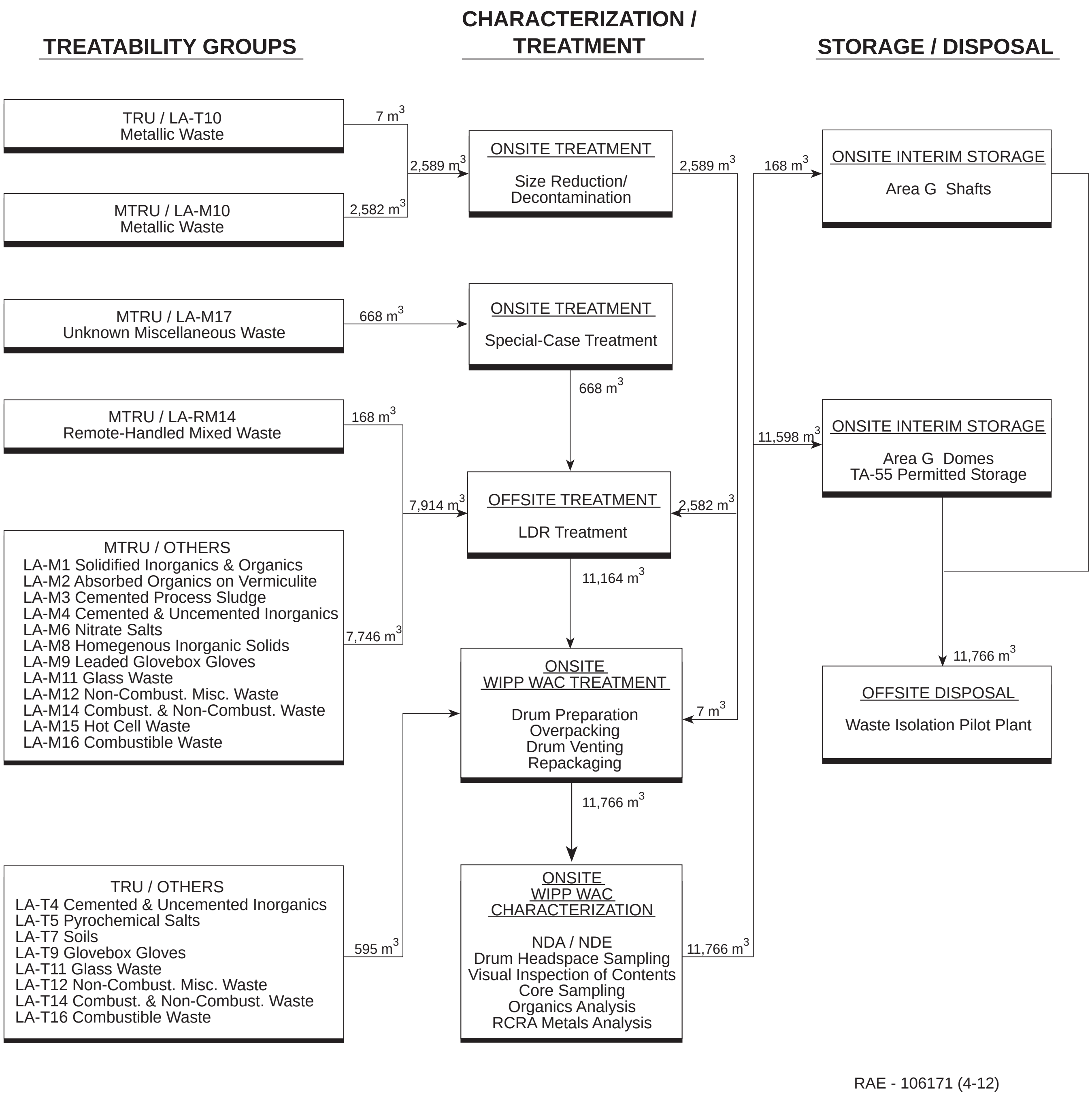

Figure 4-12. Minimum Onsite Strategy for Greener TRU Waste Volume.

5. MIXED LOW LEVEL WASTE MANAGEMENT STRATEGY

This chapter describes the generation rates, characteristics, and management options for MLLW at LANL. It addresses characterization, treatment, storage, and disposal of LANL's MLLW, as well as three MLLW management strategies: Current Path, Maximum Onsite, and Minimum Onsite. The Current Path strategy takes a cost-sensitive approach to evaluating management options and generally follows current waste management plans at LANL. The Maximum Onsite strategy considers management options, including treatment, storage, and disposal, that could be performed and/or developed on site within the 10-year time frame of the SWEIS. The Minimum Onsite strategy focuses on implementing diminished waste management functions on site that minimize environmental impacts while remaining cost effective.

5.1. MLLW Definitions and Description

MLLW contains both hazardous waste subject to regulation under RCRA and LLW subject to the Atomic Energy Act. Some examples of MLLW include tritiated mercury, mercury-contaminated items, radioactively contaminated or activated lead shielding, soils and debris contaminated with heavy metals and radioactivity, and organic aqueous liquids. MLLW has been categorized into treatability groups according to applicable treatment technologies. Radioactively contaminated PCBs, regulated under the Toxic Substances Control Act, are included with MLLW for the LANL SWEIS.

Some LANL waste is managed as MLLW even through it is not technically subject to EPA or NMED regulations. This waste category includes some commercial brands of scintillation counting "cocktails" and solidified aqueous liquids that are easier to manage as MLLW than to confirm as non-RCRA-regulated waste. These wastes are managed at a higher level of environmental protection and occupational safety than would normally be required by regulation. While these wastes could be presented in Chapter 3, they are included here because they are managed off site.

5.2. MLLW Inventories

Projections of MLLW generation by LANL operations have been developed in support of the SWEIS (LANL 1996b). The projections provide 10 year waste volume estimates for the different levels of operations considered under the four SWEIS alternatives: No Action, Expanded, Reduced, and Greener. The waste projections include contributions from the 13 key LANL facilities, other non key facilities, environmental restoration, and decontamination and decommissioning activities. In addition, wastes resulting from the CMIP and CMR Phase II upgrades have also been included. CMIP was not expected to generate significant amounts of MLLW and the CMR upgrade was projected to generate 100 m^3 of MLLW.

The waste projections and their development are described in detail in the SWEIS Waste Projections Data Package (Rogers & Associates Engineering Corporation 1996). The projected MLLW volumes for the four SWEIS alternatives are summarized, by treatability group, in Table 5-1.

The development of the MLLW treatability groups involved defining groupings of waste streams which all required the same treatment technology application, applying facility-specific historical distributions to the total projected MLLW volumes for each key facility, and summing over all the generators to arrive at the LANL total volumes. The MLLW treatability groupings have very little impact on MLLW strategies for both the Maximum Onsite case and the Minimum Onsite case. The treatability groups are however, the way in which LANL has identified appropriate treatment technologies for MLLW streams at LANL.

5.3. MLLW Management Elements

The management of MLLW at LANL is primarily driven by federal and state regulatory requirements, DOE policies and guidance, funding levels, available cost-effective technologies, and storage and disposal capabilities. Existing management of MLLW is implemented through the CST Waste Management Facilities Waste Acceptance Criteria and Certification (LANL 1994) and other administrative and detailed operating procedures in place at the generating facilities.

Several elements were considered in developing LANL's waste management strategies: characterization, treatment, storage, and disposal. The following sections describe these strategy elements and identify technology options that are available to successfully and effectively implement each waste management strategy.

5.3.1. Characterization

Waste characterization is the process of identifying and quantifying constituents of concern present in the waste streams. The purpose of waste characterization is to ensure the proper management of wastes in accordance with regulatory classification and requirements and to ensure safe handling, transportation, storage, and disposal of the waste. Characterization techniques that are currently implemented at LANL include (a) AK and (b) sampling and analysis. These characterization techniques are described in the following paragraphs.

5.3.1.1. Acceptable Knowledge

AK refers to information used for waste characterization in place of direct sampling and analysis. AK includes process knowledge and previous sampling results associated with the waste. The AK technique involves documenting the raw materials used in a process or operation, the associated material safety data sheets, the products produced, and the associated waste produced. It also involves knowing the facility or process history and all previous and current activities that affect the facility or process, which generates the waste. By properly documenting and certifying the AK to be accurate, a generator may then deduce the chemical content, radionuclide content, and physical form of the waste.

5.3.1.2. Sampling and Analysis

Sampling and analysis provide direct and accurate waste characterization information when they are performed in accordance with standard field sampling procedures and on representative waste samples. An effective sampling and analysis routine will include a sampling and analysis plan, sample handling procedures, and quality assurance and quality control procedures for both field sampling collections and laboratory sample analysis. Sampling and analysis procedures for RCRA constituents comply with EPA techniques specified in EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA 1992), commonly referred to as SW 846.

Sampling and analysis for radiological constituents are not dictated by any regulatory authority. Characterization techniques that are commonly used include direct sample acquisition for laboratory analysis (such as gamma spectroscopy, gross alpha/beta counting, liquid scintillation counting, and chemical separation/alpha spectroscopy). Indirect means can also be used. These techniques involve converting direct radiological readings to inferred concentration levels, using isotopic ratios to measure one isotope concentration, and then calculating the concentrations of other isotopes based on decay scheme and/or isotopic ratios. A number of techniques exist and are used for characterization of radiological constituents in MLLW.

5.3.2. Treatment

A great number of LDR treatment technologies exist. A comprehensive list of these technologies can be found in Table 4-3. Some of these technologies are industry-tested and feasible, while others are as yet untested. Treatment of MLLW is driven by RCRA regulations. There are a number of specified treatment technologies that can be applied to various types of MLLW. Prescribed treatment options for characteristic waste streams (those that are ignitable, corrosive, reactive, or toxic) can render the waste radioactive only in a regulatory sense, and thus allow it to be disposed of at a LLW disposal facility. MLLW, which contains hazardous constituents that are listed under RCRA (40 CFR 261.D), must be managed under RCRA requirements after treatment. This section discusses treatability groups, selection criteria for treatment options, selected treatment options for LANL waste streams, and available offsite waste management services. The treatment options discussed could be implemented on site but are also available at commercial and other federal facilities. Onsite treatment for some technologies could be performed at the generator site and/or at a centralized location.

5.3.2.1. Treatability Groups

Waste is categorized in treatability groups, which are based on waste characteristics that affect how a given waste can be treated. Treatability groups were developed based on three parameters: radiological properties, physical and chemical characteristics, and hazardous constituents. Wastes within a treatability group can generally be treated with similar technologies. Wastes in different treatability groups often require different treatment technologies.

5.3.2.2. Radiological Properties

Radiological parameters reflect the level and nature of the radioactivity in a waste and tend to drive the design of treatment, storage, and disposal facilities. These parameters reflect the isotopes present, the specific activity, and whether the radiation is penetrating (i.e., beta gamma) or non penetrating (i.e., alpha). The radiological categories of waste (as defined by DOE Order 5820.2A, “Radioactive Waste Management”) determine treatment, storage, and disposal options. Radiological constituents and activity also influence handling requirements (e.g., whether a waste can be handled directly by workers or must be handled remotely by machine). Generally, workers can handle LANL MLLW without massive or bulky shielding around the waste; however, some form of worker protection may be required. Such wastes are referred to as contact handled. MLLW must be managed in accordance with the radiological risk posed, as well as according to the risks associated with its hazardous or Toxic Substances Control Act (TSCA) constituents.

5.3.2.3. Physical and Chemical Characteristics

The radiological component of a MLLW represents a small portion of the waste volume. The physical and chemical nature of a waste greatly influences what technologies are appropriate for the waste’s treatment. For this analysis, wastes were grouped for a particular treatment based on the similarity of their physical and chemical characteristics. Each category of waste includes materials that have unique treatment or handling requirements. For example, radioactively contaminated lead is subject to specific RCRA treatment requirements and is categorized as a separate form of solid waste. Similarly, elemental mercury is subject to specific RCRA treatment requirements and is categorized as a separate form of liquid waste.

5.3.2.4. Hazardous Constituents

Appropriate treatment technologies for the hazardous constituents of a MLLW are determined according to regulation or technical feasibility. The primary categories of hazardous waste are listed wastes and characteristic wastes. Some wastes may possess attributes of both of these waste types.

Based on their hazardous content, most wastes have specific regulatory requirements for treatment, storage, and disposal. Regulatory drivers are RCRA and TSCA.

RCRA defines a hazardous waste as hazardous according to its quantity, hazardous concentrations, or physical and chemical characteristics. Hazardous waste includes waste that may pose a substantial present or future hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Materials regulated under TSCA include PCBs and asbestos. Asbestos is also regulated by other requirements. The presence of these contaminants above regulatory thresholds results in specific requirements on how a waste must be managed. PCB contaminated materials are subject to treatment standards that specify more stringent destruction and removal efficiencies. Low-level asbestos waste is addressed in Chapter 3 of this document.

5.3.2.5. Screening Process for Treatment Technology Selection

Selection criteria for treatment of a given waste stream are based on the technical feasibility of destroying the hazardous constituents of the waste, of removing the hazardous constituent, or of immobilizing the hazardous constituent. The criteria also are based on treatment requirements of RCRA and the available offsite services.

5.3.2.6. Available Offsite Providers

Several facilities are available for offsite treatment of LANL's MLLW. These include the:

- Waste Experimental Reduction Facility (WERF) Incinerator at DOE's Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho.
- Diversified Scientific Services, Inc., facility in Kingston, Tennessee.
- Consolidated Incineration Facility at DOE's Savannah River Site.
- TSCA incinerator at DOE's Oak Ridge Reservation in Tennessee.
- Nuclear Fuel Services facility in Erwin, Tennessee.
- Envirocare of Utah facility in Clive, Utah.

The WERF Incinerator is operated under a RCRA permit. This facility can accept liquid, aqueous, liquid organic, and solid wastes that fall under EPA codes D, F, P, and U. It cannot accept the following:

- PCB-contaminated waste.
- Asbestos.
- Large metal objects.
- Waste with concentrations of heavy metals, total chlorine, total fluorine, and total halogen that exceed 5,000, 10,000, 3,500, and 10,000 ppm, respectively.
- Etiologic agents.
- Pyrophorics.
- Explosives.
- Unstabilized, shock-sensitive waste.

- Pressurized containers.
- Beryllium from beryllium sources.

Shippers to the WERF Incinerator must submit forms 669 and 669A, which document waste characterization and certification on behalf of the shipper. Solid waste shipped to the facility must be packaged in 2x2x2-foot corrugated cardboard boxes. Liquids sent to the facility must be packaged in DOT 17E drums with fixed heads and threaded closures. The facility's waste acceptance criteria prohibit acceptance of bulk liquids or solids.

Diversified Scientific Services operates a recycling facility that uses an industrial boiler to combust solvents to generate electricity. This facility is operated under a RCRA Part B Permit and can accept waste solvents, wastewater contaminated with organics, used oil, nonhazardous organic liquids (radioactive only), scintillation cocktails, and lab packs. It also can accept waste under the following EPA codes:

- D001, D002, and D004 through D043.
- F001 through F-012, F019, F024, F025, F028, F032, F034, F035, F037, F038, and F039.
- All P codes.
- All U codes.

The Diversified Scientific Services facility cannot accept solid wastes, aqueous metal-only wastes, PCB-contaminated waste, reactive waste, dioxins, or waste under EPA codes D003, F020, F021, D022, F023, F026, and F027.

The Consolidated Incineration Facility also is operated under a RCRA permit. This facility can accept MLLW, hazardous waste, and LLW that originates on site. It can also accept wastes under EPA codes D001-D043, F001 through F006, and most U and P codes. The facility can not accept the following offsite materials:

- Lab packs.
- Medical wastes.
- Wood chips.
- Waste in containers.
- Explosives.
- Alkali metals.
- Cyanides.
- Reactives.
- Propellants.
- PCB-contaminated waste.
- High-mercury wastes.
- TRU wastes.
- Organic debris with inorganic metals.

- All waste not under accepted EPA codes.

The TSCA Incinerator is a DOE facility permitted to accept waste under EPA codes D, F, P and U. Waste streams that can be accepted at this facility include those in EPA Groups 18, 19, 20, 26, 28, and 29. The facility can not accept any wastes in the form of gases or solids.

The Nuclear Fuel Services facility employs a wide range of technologies to treat radioactively contaminated materials. Operated under a RCRA Part B Permit, this facility accepts waste materials on a case-by-case basis.

The Envirocare of Utah facility operates under a State of Utah Mixed Waste permit. It accepts naturally occurring radioactive materials, LLW, and MLLW for land disposal. The facility is permitted to treat solid matrix MLLW through stabilization to meet the LDR treatment standard. Envirocare can- not accept the following:

- Free liquids.
- Materials with PCB concentrations exceeding 50 ppm.
- Lab packs.
- Class A or B explosives.
- Sealed sources.
- Water reactives.
- Dioxins.
- Compressed gases.

5.3.2.7. Treatment Options Selected

The treatment options discussed in this section are available from offsite commercial and other federal facilities. In most cases, DOE facilities will return any residues that result from treatment. In some cases, the residue will be LLW, which can be disposed of at Area G. Other residues will remain MLLW and will require disposal at a permitted facility. Treatment options discussed in this section could also be developed on site. Several of the treatment options could be developed by each of the generators, while others would need to be developed as a centralized LANL capability. Refer to Section 5.3.2.6 for a description of offsite providers of these services.

5.3.2.7.1. Incineration (Thermal Treatment)

Incineration is a thermal treatment made up of several technologies, which use heat to destroy organic wastes. In the case of wastes with low heating value, energy is added to the thermal treatment process in the form of fuel or electricity to raise the temperature high enough to destroy essentially all of the organic components in a mixed waste stream. However, some waste products may have sufficient fuel heating value to sustain their own combustion. Incineration of most organic liquid MLLW produces little or no ash, resulting in volume reduction factors as high as 1,000 to 1. However, incinerating MLLW solids and sludges produces considerably lower volume reduction factors. Ash or residue from incinerating listed waste remains a hazardous waste until it is delisted. Additional treatment of residue (e.g., vitrification or solidification) may be needed for the delisting process. For the purposes of estimating the volume of residual wastes from incineration in the SWEIS waste management strategies analysis the following volume reduction ratios are applied:

• Liquids	1,000:1
• Combustible debris	100:1
• Non-combustible debris	1:1
• Soils	1:1
• Non-RCRA chemical LLW	100:1

Off gas treatment of incinerated MLLW typically includes scrubbers for removal of acid gases, catalysts for removing nitrogen oxides and carbon monoxide, particulate removal, and a bank of HEPA filters producing spent scrubbing fluids, resins used to regenerate scrubbing solutions, catalysts, and filters. These secondary wastes may also be MLLW if the waste being treated was a listed waste or if the secondary waste stream exhibits any hazardous characteristics.

Incineration is not an effective treatment for hazardous metals and other inorganics. However, if the waste stream contains more than one listed component or characteristic, incineration could provide treatment for that component as well as volume reduction for the metals and inorganics. A RCRA permit would be required to implement this technology on site.

While it is technically feasible for this technology to be developed on site, the political and administrative challenges would be formidable. At this point, the State of New Mexico has regulations that preclude the permitting of an incinerator until such time as procedures are developed for the permitting process. The development of these procedures has not been funded by the State of New Mexico. However, because the goal of the Maximum Onsite strategy is to explore and envelop the body of possible options, it was assumed for this analysis that this technology could be developed on site.

5.3.2.7.2. Physical Separation of Hazardous and Radioactive Components

Some waste streams can be treated by physically separating the hazardous and radioactive components from one another. Methods such as filtration, precipitation, leaching, and dewatering may be applied for physical separation. Separation technologies work by exploiting differences in size, solubility, charge, density, volatility, and other physical properties. In general, these are simple technologies that could be performed on site with very little development costs or time.

5.3.2.7.3. Decontamination

Standard radiological decontamination measures can be applied to materials that are contaminated with both hazardous constituents and radiological constituents. The resultant secondary waste will still be a MLLW; however, the secondary waste represents a greatly reduced volume. Some standard technologies include carbon dioxide blasting, simple scrubbing, and the use of various non hazardous chemical agents (i.e., chelating agents). These techniques could be implemented on site or be sent off site for decontamination and returned to LANL. Application of this technology does not require a RCRA permit.

5.3.2.7.4. Solidification and Stabilization

Stabilization and solidification are processes that encapsulate the waste in a monolithic solid with high structural strength. Solidification does not necessarily involve a chemical interaction between the waste and the solidification agents. Stabilization is a process that reduces the hazard potential of a waste by converting the contaminants to their least soluble, mobile, or toxic form. Because organics typically, but not always, leach from the product of these treatment methods, solidification processes are normally applied to wastes containing appreciable quantities of heavy metals and inorganic salts. Macro-encapsulation is a solidification process by which polymeric materials are mixed together with debris to form a cured, stable matrix.

Experimentation has shown that materials such as asphalt, glass, cement, and plastic materials are effective in encapsulating radioactive and hazardous constituents, thereby eliminating leaching. Maintaining integrity of these materials over long periods involves special engineering considerations. The encapsulating material must remain nonleachable as long as the waste material remains hazardous. Macro encapsulation is the specified treatment technology based on 40 CFR 268 treatment standards for the radioactive lead solid subcategory, which includes lead shielding and other elemental forms of lead.

These technologies are simple, well proven, and would require little development. Application of this technology to a substantial volume of LANL MLLW could allow burial at Area G, thereby eliminating transportation issues. Potentially, the technology is simple enough that, under the Maximum Offsite strategy, an individual facility may find it efficient to implement it if it does not exist centrally. A RCRA permit is required to implement this technology.

While solidification provides a stable waste form, the addition of additional mix materials increases the volume of waste to be managed. For the purposes of this analysis, debris subjected to stabilization undergoes a five-fold volume increase and lead waste subjected to macro-encapsulation undergoes a three-fold volume increase.

5.3.2.7.5. Chemical Treatments

Various chemical treatments can be used for removing the hazardous component from MLLW. These include neutralization for adjusting pH (can be achieved by bulking), precipitation for removing metals from solution, and organic chemical dechlorination. Other treatments such as oxidation, ion exchange, reduction, and electrochemical treatments are applicable to treating waste waters with trace amounts of contaminants. Neutralization is a simple technology that can be implemented on site. Electrochemical treatments for extraction of metals from liquids is a technology that would be amenable to onsite development. After these treatments, many waste waters can be treated at TA-50 and discharged in accordance with the National Pollutant Discharge Elimination System (NPDES) permit. Offsite chemical treatment services are also available.

5.3.2.7.6. Gas Cylinder Oxidation/Scrubbing

This treatment involves the release of the compressed, radioactively contaminated gas into a controlled environment for reuse or treatment of the gas. Depending on the gas, some combination of oxidation, caustic scrubbing, acid scrubbing, and water scrubbing will prove effective in the treatment of compressed gas cylinders. For onsite development of this treatment, mobile treatment skids would likely be used. A RCRA permit would be required to implement this technology. Several offsite commercial options are also potential treatments for gas cylinders. One technology is incineration, and the other is a molten metal melt procedure.

5.3.3. Storage

RCRA storage capacity is available at both Area L and Area G. At Area L there are 380 m^3 of RCRA storage capacity in the dome. Of this capacity, 7.5 m^3 are available for gas cylinders, 42 m^3 are available for tritium, 2.25 m^3 are in lead stringer shafts, and 911 m^3 are available at Dome 49 in Area G. Historically, this capacity has been adequate; however, as the Environmental Restoration Project moves forward into remediation activities, additional storage capacity may be required.

5.3.4. Disposal

The ultimate disposition of MLLW is disposal. Currently, MLLW generated at LANL is disposed off site. Disposal options exercised by LANL at this time are limited to commercial MLLW disposal sites. DOE disposal sites may be available in the future. This section discusses current and potential offsite disposal locations, as well as an onsite MLLW disposal facility.

5.3.4.1. Onsite Disposal

A Mixed Waste Disposal Facility (MWDF) could be sited in an area on LANL property that is restricted from the public by security fences and guard stations. The MWDF would be constructed and operated in stages to minimize the amount of cell excavation required in case the amount of MLLW requiring disposal should be less than projected. The MWDF would consist of a segmented series of below grade cells within the overall disposal pit area. The cell liners and permanent covers would be constructed to prevent migration of contaminants into the environment, and a monitoring and alarm system would be installed.

Site selection would be based on criteria such as minimum acreage requirements, ability to construct disposal cells away from canyon walls to avoid site disruption if walls recede, and compatibility with planned land uses. Further criteria would include geotechnical aspects such as the presence of a thick tuff layer, absence of faults, depth of groundwater, absence of perched water, absence of fractures, and a location that is not up-gradient from water wells. Other goals of site selection would be the absence of archaeological sites and endangered species. Also under consideration would be the site's proximity to non DOE property and areas of population, transport distances and security constraints, and onsite development costs.

The initial construction for the first phase of a MWDF would include utilities, buildings, treatment facilities, site improvements, storm water detention tanks, and a limited number of disposal cells. The construction sequence for such a project would start with site clearing and improving site access. Following would be excavation of the initial disposal area; site grading; disposal area, road, and building construction; storm water tank installation; and final site improvements (such as paving, fencing, erosion control, and seeding). Final construction would focus on developing the remaining disposal cells as they are needed. This phase would include site clearing, excavation for cells, construction of disposal cell liners and covers, and final site improvements.

The disposal area would consist of adjoining disposal cells. The construction sequence of the disposal pit would start at one end of the site and proceed toward the other as additional disposal capacity is needed. New cells would be excavated outside controlled areas to prevent contamination of the excavated material.

RCRA regulations for the design, construction, operation, and maintenance of liner systems for RCRA landfills are very specific. The owner/operator of a facility such as the MWDF may use alternative designs or operating practices, as approved by the appropriate regulatory agency (or agencies). This may occur only if the owner/operator demonstrates that the alternative design and operating practices, together with location characteristics, will prevent migration of hazardous constituents and allow detection of leaks at least as effectively as the design and operating practices prescribed in the regulations.

A leachate collection system would be designed to manage the precipitation that collects in the cells. The leachate system design would allow withdrawal of fluids from the disposal cells and storage in a leachate storage tank. The leachate would then be treated in a wastewater treatment facility. A leak detection system below the primary liner would monitor for leaks and collect any leachate to prevent the leachate from reaching the tuff below.

Cover design will meet performance objectives and guidance, including long term containment of the cell contents. Cell cover design would incorporate various components to control erosion, mitigate the effects of any waste settlement, limit infiltration, provide freeze/thaw protection, drain or shed precipitation, control bio intrusion (i.e., keep rodents and other burrowing animals from entering), and allow self renewal of the vegetation on the cover after the native vegetation has been planted and matured.

Operational efforts required to ensure the safe and regulation-compliant disposal of waste at a MWDF include waste acceptance testing, waste staging, waste treatment, wastewater treatment, and waste disposal in the proper segment of a designated disposal cell.

At closure, infrastructure facilities would be tested and decontaminated if necessary. These buildings would not be subject to the same monitoring and upkeep that would be required for the disposal cells, but if the buildings were to be demolished, a separate NEPA document would be prepared. Monitoring of cell leachate and upkeep of cell covers during the 30 year post closure period prescribed by RCRA would likely be accomplished intermittently by LANL personnel based at active facilities.

5.3.4.2. Offsite Disposal

Offsite disposal options include both federal and commercial facilities. A description of available and potential offsite services can be found in Section 5.3.2.6. In general, commercial facilities will provide both treatment and disposal services, while most federal facilities provide only treatment options with residual LLW or MLLW being returned to LANL. All offsite waste shipments would require adherence to the facility's waste acceptance criteria and compliance with DOT regulations.

Of the federal facilities evaluated, only the NTS has the potential for MLLW disposal. At this point, the NTS cannot accept MLLW from off site. It is assumed that the NTS will eventually be allowed to accept MLLW. The NTS has complex waste acceptance criteria that require rigorous certification at the generator site. LANL would need to develop policies and procedures to meet the certification requirements.

Several commercially operated facilities provide both treatment and disposal services (see Section 5.3.2.6). When combined, the services offered by these facilities could allow offsite disposal of virtually all of the MLLW generated at LANL. Also, residual MLLW that is returned after treatment at other facilities can usually be accepted by an offsite facility. The pathway for this waste begins with the waste being sent offsite to a treatment facility, then moves to the treatment residual being returned to LANL, follows with LANL characterization of the residual and preparation of the residual according to the disposal facility's waste acceptance criteria, and ends with the residual being sent off site to the disposal facility.

5.4. MLLW SWEIS Strategies

Three different MLLW management strategies have been developed based on DOE direction. The three strategies are Current Path, Maximum Onsite, and Minimum Onsite. Section 5.4.1 presents the viable treatment, storage, and disposal (TSD) options and describes how they are implemented in the three MLLW strategies. Sections 5.4.2, 5.4.3, and 5.4.4 apply the three strategies to the waste volumes resulting from the four SWEIS alternatives. Section 5.4.5 summarizes and compares each of the alternatives.

5.4.1. Strategies Development and Assumptions

Potential TSD options for MLLW management are described in Section 5.3. Table 5-2 lists those options that are applicable to the management of MLLW at LANL. The table indicates which option will be exercised and by whom for each of the three strategies. Capabilities were selected for each of the three strategies based on DOE guidance to create the Maximum Onsite and Minimum Onsite strategies. The Maximum Onsite and Minimum Offsite scenarios were developed by DOE with the goal of encompassing and describing the range of possible management options. Thus, an optimistic assumption was made that the appropriate treatment and disposal options for managing MLLW on site could be developed within the 10 year time frame of the SWEIS.

5.4.1.1. Current Path Strategy

The Current Path strategy reflects the activities that LANL is currently funded to perform, as well as additional treatment options that could prove cost effective and environmentally preferable. It reflects LANL's current plan for managing MLLW. The selection of options is the culmination of DOE policy, budgetary limitations, and the existence of offsite capabilities. Those treatment technologies pursued for onsite implementation tend to be simple and applicable to characteristic waste streams. These technologies can be developed relatively cost-effectively. Furthermore, given that Area G is an operating LLW disposal facility, these treated wastes can be disposed of on site, thereby eliminating transportation considerations. Figures 5-1 through 5-4 indicate the waste flow by treatability group for the four LANL SWEIS alternatives: No Action, Expanded, Reduced, and Greener. Table 5-3 summarizes the total MLLW projected volumes, the as-disposed volumes, and the ultimate disposal option exercised for the Current Path strategy when applied to the LANL SWEIS alternative waste quantities.

As shown in the tables and flow charts, waste quantities generated under the four LANL SWEIS alternatives do not change the strategy elements or waste flow under the Current Path strategy. These diagrams and tables also show that solidified ER soils comprise a significant volume and will contribute to the LLW volumes. At this point, all treatment technologies selected as onsite options would require RCRA permits, which LANL does not possess at this time. For the Current Path strategy, it was assumed that all of the treatment capabilities and shipments will be managed at a centralized location.

5.4.1.2. Maximum Onsite Strategy

The Maximum Onsite strategy assumes that LANL will manage all MLLW it generates. This strategy puts forth all the elements that would need to occur on site for LANL to accomplish this goal. It would involve the development and permitting of a number of treatment technologies and the siting, permitting, and construction of both an incinerator and MWDF. Development of these technologies would require extensive planning, development, costs, and commitment of time and effort. The rationale for development of this model involves applying the same technologies that are applied by offsite facilities and moving them on site. An important linkage among these elements is that between developing an incinerator and an MWDF. Both facilities are included in this strategy because it would not be efficient to have one without the other. If there were no onsite incinerator, LANL waste would need to be shipped off site for incineration and then shipped back to be disposed of on site. On the other hand, if there were an incinerator without onsite disposal capability, incinerated waste would still need to be shipped off site for disposal. In either case, the local environmental impacts would increase despite the benefits achieved by avoiding waste transportation.

Figures 5-5 through 5-8 indicate the waste flow by treatability group for the four LANL SWEIS alternatives: No Action, Expanded, Reduced, and Greener. Table 5-5 summarizes the total MLLW projected volumes, the as-disposed volumes, and the ultimate disposal option exercised for the Maximum Onsite strategy when applied to the LANL SWEIS alternative waste quantities.

As shown in the tables and flow charts, waste quantities generated under the four LANL SWEIS alternatives do not change the strategy elements or waste flow under the Maximum Onsite strategy. These diagrams and tables also show that solidified ER soils comprise a significant volume and will contribute to the LLW volumes. At this point, all treatment technologies selected as onsite options would require RCRA permits, which LANL does not possess at this time. For the Maximum Onsite strategy it was assumed that all of the treatment capabilities and shipments will be managed at a centralized location.

5.4.1.3. Minimum Onsite Strategy

The Minimum Onsite strategy assumes that LANL will perform only those treatments that are simple to implement and develop, that would be cost effective, and that would minimize local impacts. The treatment technologies proposed for onsite implementation are those that could be applied to characteristic waste, leading to disposal at Area G. In this way, transportation costs and risks could be minimized while using existing disposal capability. Further, including simple onsite treatment options allows the possibility that individual facilities could implement them if they prove cost effective.

Figures 5-9 through 5-12 indicate the waste flow by treatability group for the four LANL SWEIS alternatives: No Action, Expanded, Reduced, and Greener. Table 5-5 summarizes the total MLLW projected volumes, the as-disposed volumes, and the ultimate disposal option exercised for the Minimum Onsite strategy when applied to the LANL SWEIS alternative waste quantities.

As shown in the tables and flow charts, waste quantities generated under the four LANL SWEIS alternatives do not change the strategy elements or waste flow under the Minimum Onsite strategy. These diagrams and tables also show that solidified ER soils comprise a significant volume and will contribute to the LLW volumes. At this point, all treatment technologies selected as onsite options would require RCRA permits, which LANL does not possess at this time. For the Minimum Onsite strategy it was assumed that any of the treatment capabilities and shipments could be managed by the generator if doing so proves cost effective and if a centralized capability does not exist.

5.5. Strategies Comparison

Tables 5-6 through 5-9 summarize waste flows by SWEIS alternative for each of the three MLLW management strategies. Waste volumes do not influence decisions regarding what strategy elements will be performed on site as opposed to off site under any model. The overriding decision criterion was to create the Maximum Onsite and Minimum Offsite strategies. Further, distributions of waste stream treatability groups were not found to vary significantly across the alternatives.

Table 5-1. Ten-year cumulative MLLW inventories for the four SWEIS alternatives.

ID	Treatability Group	No Action (m^3)	Expanded (m^3)	Reduced (m^3)	Greener (m^3)
M01	Surface-Contaminated Lead	190	197	189	190
M02	Soils & Debris Contaminated with Heavy Metals	2,816	2,816	2,816	2,816
M03	Non-Organic Non-Combustible Debris	28	32	28	28
M04	Liquids Contaminated with Heavy Metals	6	6	6	6
M05	Inorganic Solid Oxidizers	2	2	2	2
M06	Water Reactives	8	8	8	8
M07	Corrosives	3	3	3	3
M08	Inseparable Lead Waste	193	204	191	196
M09	Organic Liquids	95	96	95	96
M10	Organic Aqueous Liquids	12	12	12	12
M11	Combustible Debris	133	136	133	134
M12	Organic Non-Combustible Debris	94	94	94	94
M13	ER Soils with Organics	2,674	2,674	2,674	2,674
M14	Non-RCRA Low-Level Waste	610	672	605	622
M15	Gas Cylinders	7	7	7	7
M16	Mercury	112	121	109	117
ALL	TOTAL	6,983	7,080	6,972	7,005

Table 5-2. Implementation matrix for TSD options and MLLW management strategies.

TSD Capability	Current Path	Maximum Onsite	Minimum Onsite
Treatment			
Decontamination	Onsite	Onsite	Offsite
Thermal treatment/incineration	Offsite	Centralized onsite	Offsite
Stabilization	Centralized onsite (or offsite)	Generator site and/or centralized onsite	Generator site and/or offsite
Chemical treatments	Centralized onsite	Generator site and/or centralized onsite	Generator site and/or offsite
Scrubbing / Oxidation	Offsite	Centralized onsite	Offsite
Amalgamation	Offsite	Centralized onsite	Offsite
Macro-encapsulation	Offsite	Generator site and/or centralized onsite	Generator site and/or offsite
Storage			
RCRA-permitted	Centralized onsite	Centralized onsite	Generator site and/or centralized onsite
Disposal			
Commercial facilities	Used	Not used	Used
Other federal facilities	Used	Not used	Used
Area G	Used	Used	Not used
Onsite MWDF	Not used	Used	Not used

Table 5-3. Composite disposition of MLLW inventories under the Current Path strategy.

SWEIS Alternative	As-Generated Volume (m^3)		Net Volume Increase	As-Disposed Volume (m^3)	
No Action	6,373	RCRA	158%	14,250	Area G
	610	Non-RCRA		3,586	Permitted off site facility
	6,983	Total		13	Treated at TA-50
				190	Recycle
				18,039	Total
Expanded	6,408	RCRA	156%	14,270	Area G
	672	Non-RCRA		3,637	Permitted off site facility
	7,080	Total		13	Treated at TA-50
				197	Recycle
				18,117	Total
Reduced	6,367	RCRA	159%	14,250	Area G
	605	Non-RCRA		3,573	Permitted off site facility
	6,972	Total		13	Treated at TA-50
				189	Recycle
				18,025	Total
Greener	6,383	RCRA	158%	14,250	Area G
	622	Non-RCRA		3,605	Permitted off site facility
	7,005	Total		13	Treated at TA-50
				190	Recycle
				18,058	Total

Table 5-4. Composite disposition of MLLW inventories under the Maximum Onsite strategy.

SWEIS Alternative	As-Generated Volume (m^3)		Net Volume Increase	As-Disposed Volume (m^3)	
No Action	6,373	RCRA	158%	14,250	Area G
	610	Non-RCRA		3,586	Permitted on site facility
	6,983	Total		13	Treated at TA-50
				190	Recycle
				18,039	Total
Expanded	6,408	RCRA	156%	14,270	Area G
	672	Non-RCRA		3,637	Permitted on site facility
	7,080	Total		13	Treated at TA-50
				197	Recycle
				18,117	Total
Reduced	6,367	RCRA	153%	14,250	Area G
	605	Non-RCRA		3,191	Permitted on site facility
	6,972	Total		13	Treated at TA-50
				189	Recycle
				17,643	Total
Greener	6,383	RCRA	158%	14,250	Area G
	622	Non-RCRA		3,605	Permitted on site facility
	7,005	Total		13	Treated at TA-50
				190	Recycle
				18,058	Total

Table 5-5. Composite disposition of MLLW inventories under the Minimum Onsite strategy.

SWEIS Alternative	As-Generated Volume (m^3)		Net Volume Increase	As-Disposed Volume (m^3)	
No Action	6,373	RCRA	158%	0	Area G
	610	Non-RCRA		17,849	Permitted off site facility
	6,983	Total		0	Treated at TA-50
				190	Recycle
				18,039	Total
Expanded	6,408	RCRA	156%	0	Area G
	672	Non-RCRA		17,920	Permitted off site facility
	7,080	Total		0	Treated at TA-50
				197	Recycle
				18,117	Total
Reduced	6,367	RCRA	159%	0	Area G
	605	Non-RCRA		17,836	Permitted off site facility
	6,972	Total		0	Treated at TA-50
				189	Recycle
				18,025	Total
Greener	6,383	RCRA	158%	0	Area G
	622	Non-RCRA		17,868	Permitted off site facility
	7,005	Total		0	Treated at TA-50
				190	Recycle
				18,058	Total

Table 5-6. Waste flows for the three MLLW strategies applied to No Action MLLW volumes.

Capability	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	6,983	6,983	6,983
Treatment			
Onsite treatment	3,060	6,983	7
Offsite treatment	3,923	0	6,976
No treatment	0	0	0
Storage	Variable to capacity	Variable to capacity	Variable to capacity
Disposal			
Offsite	3,586	0	17,849
Area G	14,250	14,250	0
Onsite MWDF	0	3,586	0
Recycle	190	190	190

Table 5-7. Waste flows for the three MLLW strategies applied to Expanded MLLW volumes.

Capability	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	7,080	7,080	7,080
Treatment			
Onsite treatment	3,071	7,080	7
Offsite treatment	5,009	0	7,073
No treatment	0	0	0
Storage	Variable to capacity	Variable to capacity	Variable to capacity
Disposal			
Offsite	3,637	0	17,920
Area G	14,270	14,270	0
Onsite MWDF	0	3,637	0
Recycle	197	197	197

Table 5-8. Waste flows for the three MLLW strategies applied to Reduced MLLW volumes.

Capability	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	6,972	6,972	6,972
Treatment			
Onsite treatment	3,059	6,972	7
Offsite treatment	3,913	0	6,965
No treatment	0	0	0
Storage	Variable to capacity	Variable to capacity	Variable to capacity
Disposal			
Offsite	3,573	0	17,836
Area G	14,250	14,250	0
Onsite MWDF	0	3,191	0
Recycle	189	189	189

Table 5-9. Waste flows for the three MLLW strategies applied to Greener MLLW waste volumes.

Capability	Current Path (m^3)	Maximum Onsite (m^3)	Minimum Onsite (m^3)
Characterization	7,005	7,005	7,005
Treatment			
Onsite treatment	3,060	7,005	7
Offsite treatment	3,945	0	6,998
Other	0	0	0
Storage	Variable to capacity	Variable to capacity	Variable to capacity
Disposal			
Offsite	3,605	0	17,868
Area G	14,250	14,250	0
Onsite MWDF	0	3,605	0
Recycle	190	190	190

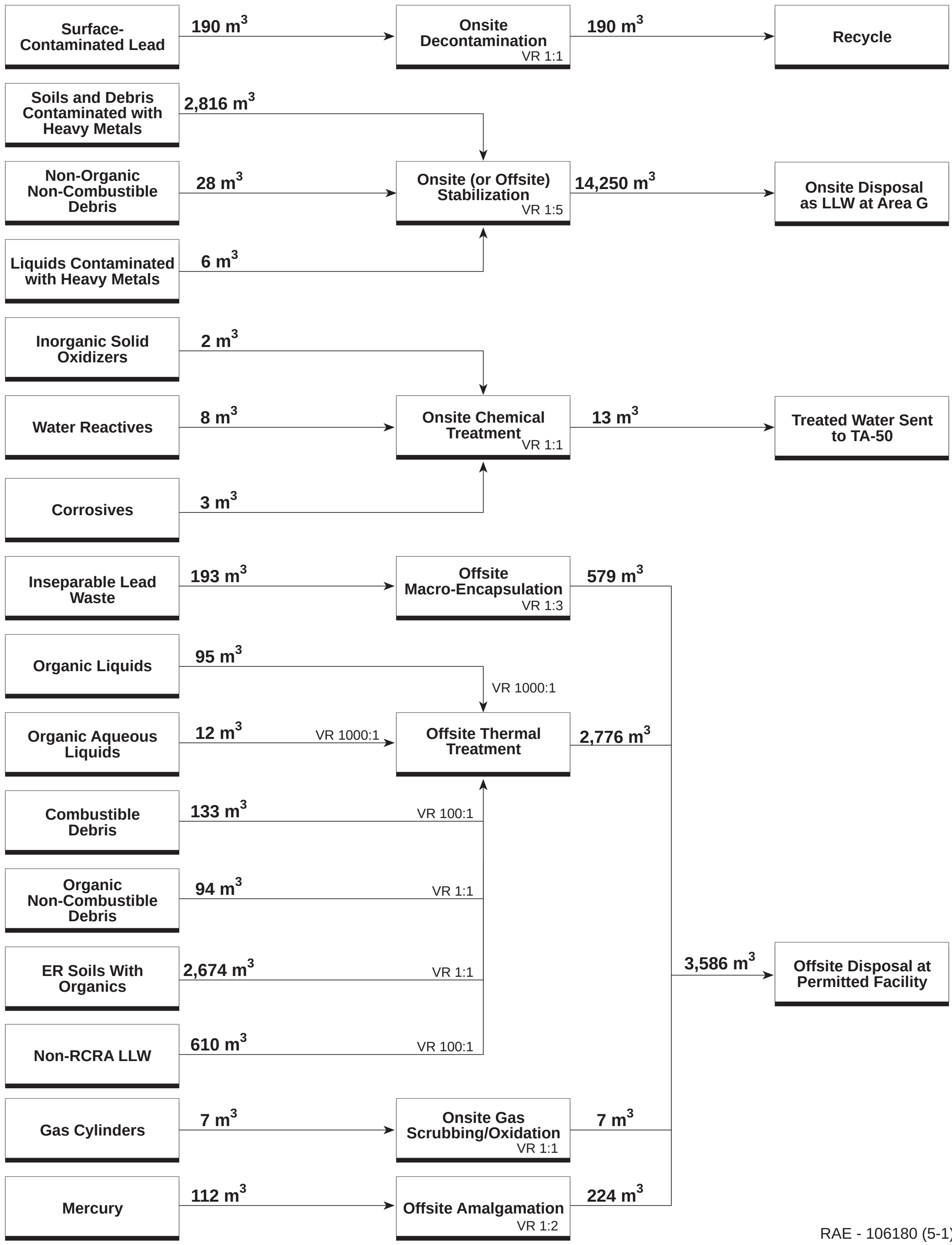

Figure 5-1. Current Path Strategy for No Action MLLW Volumes.

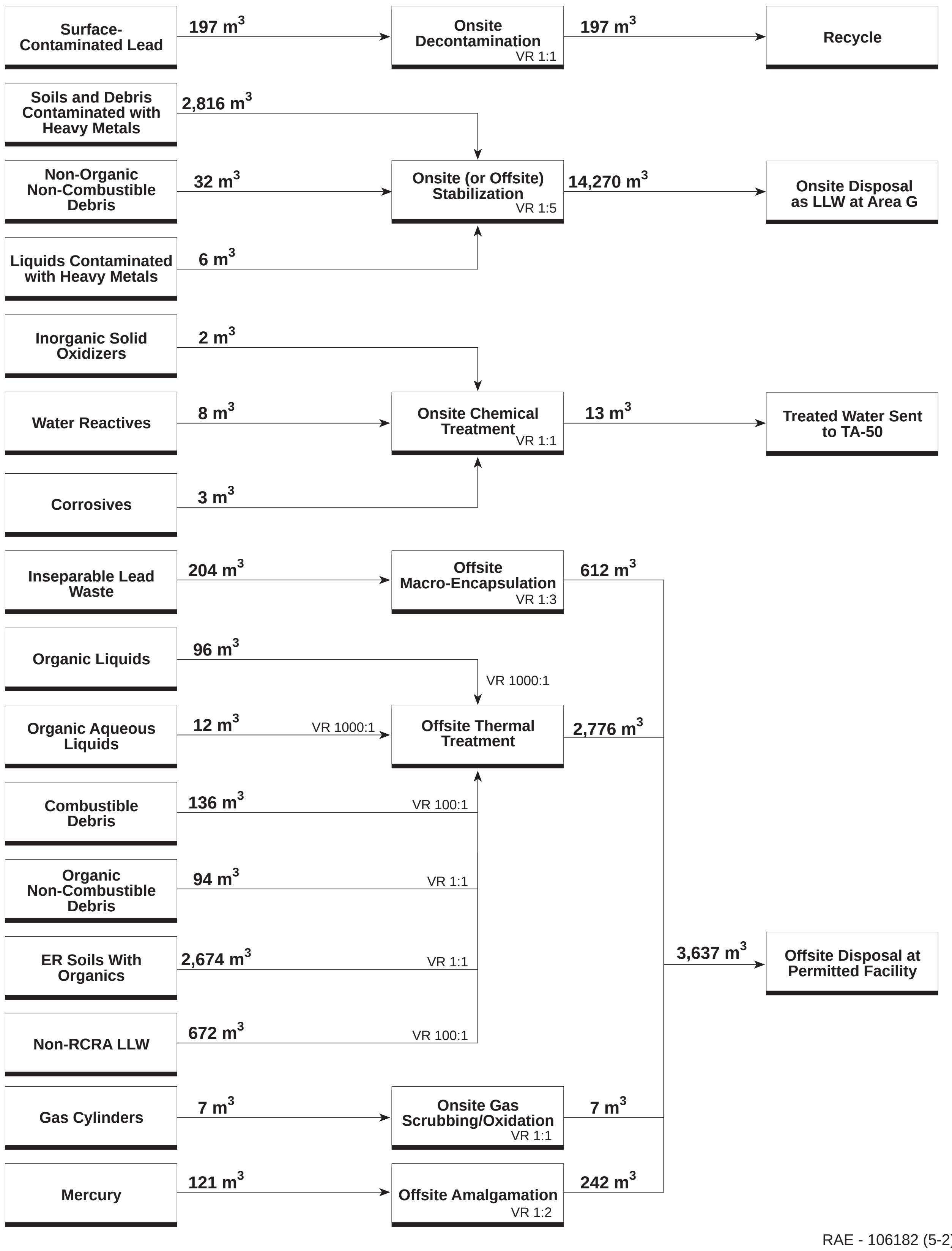

Figure 5-2. Current Path Strategy for Expanded MLLW Volumes.

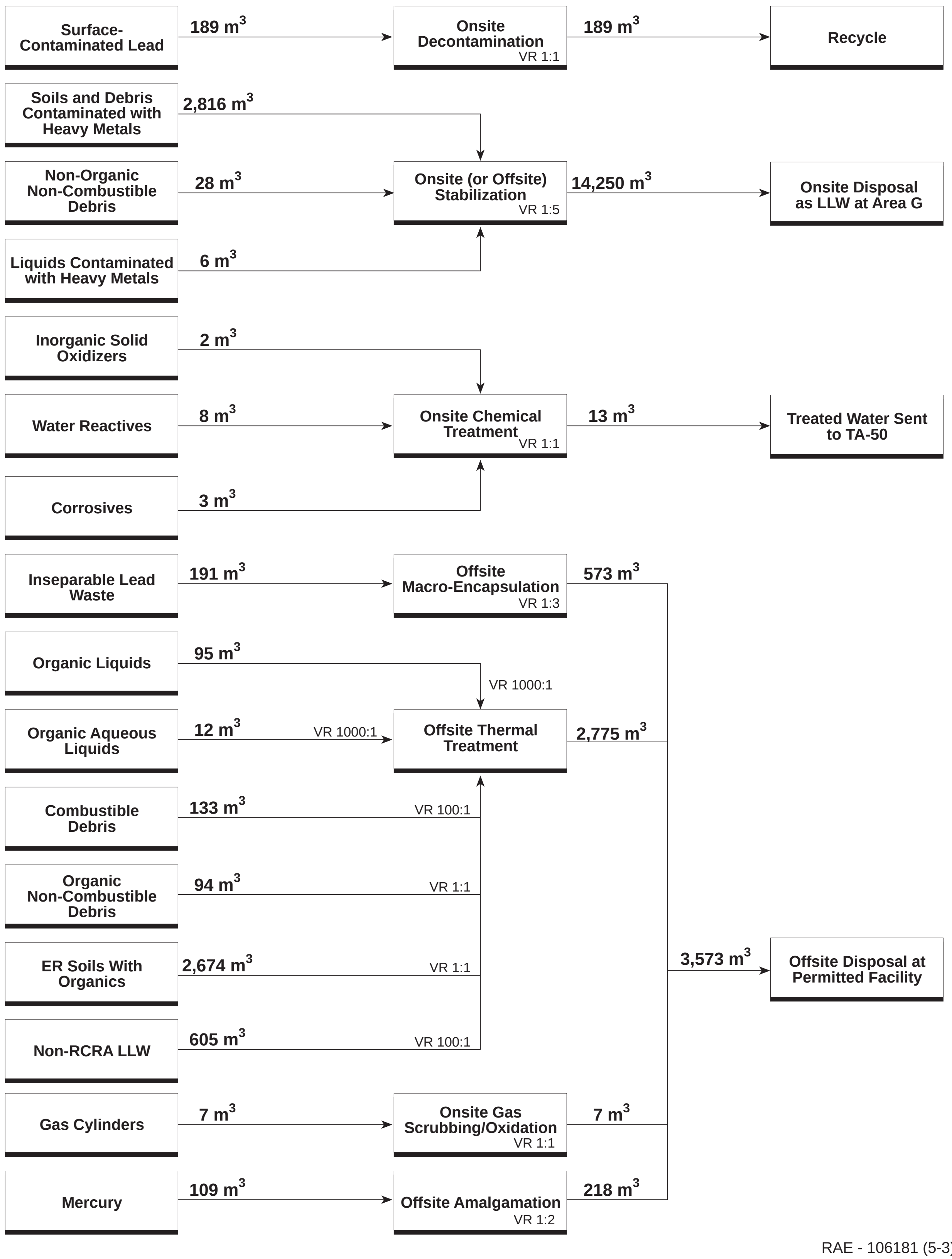

Figure 5-3. Current Path Strategy for Reduced MLLW Volumes.

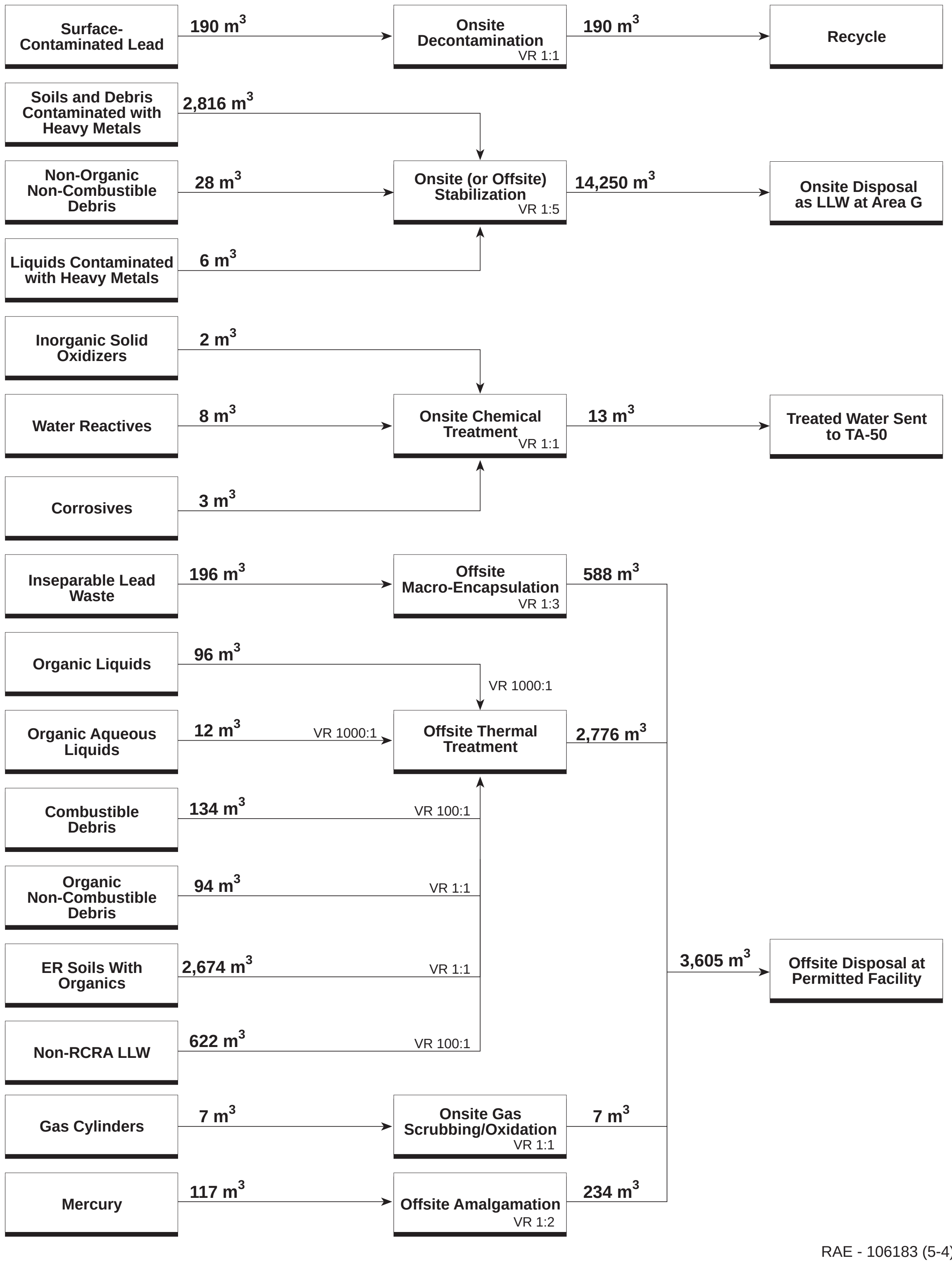

Figure 5-4. Current Path Strategy for Greener MLLW Volumes.

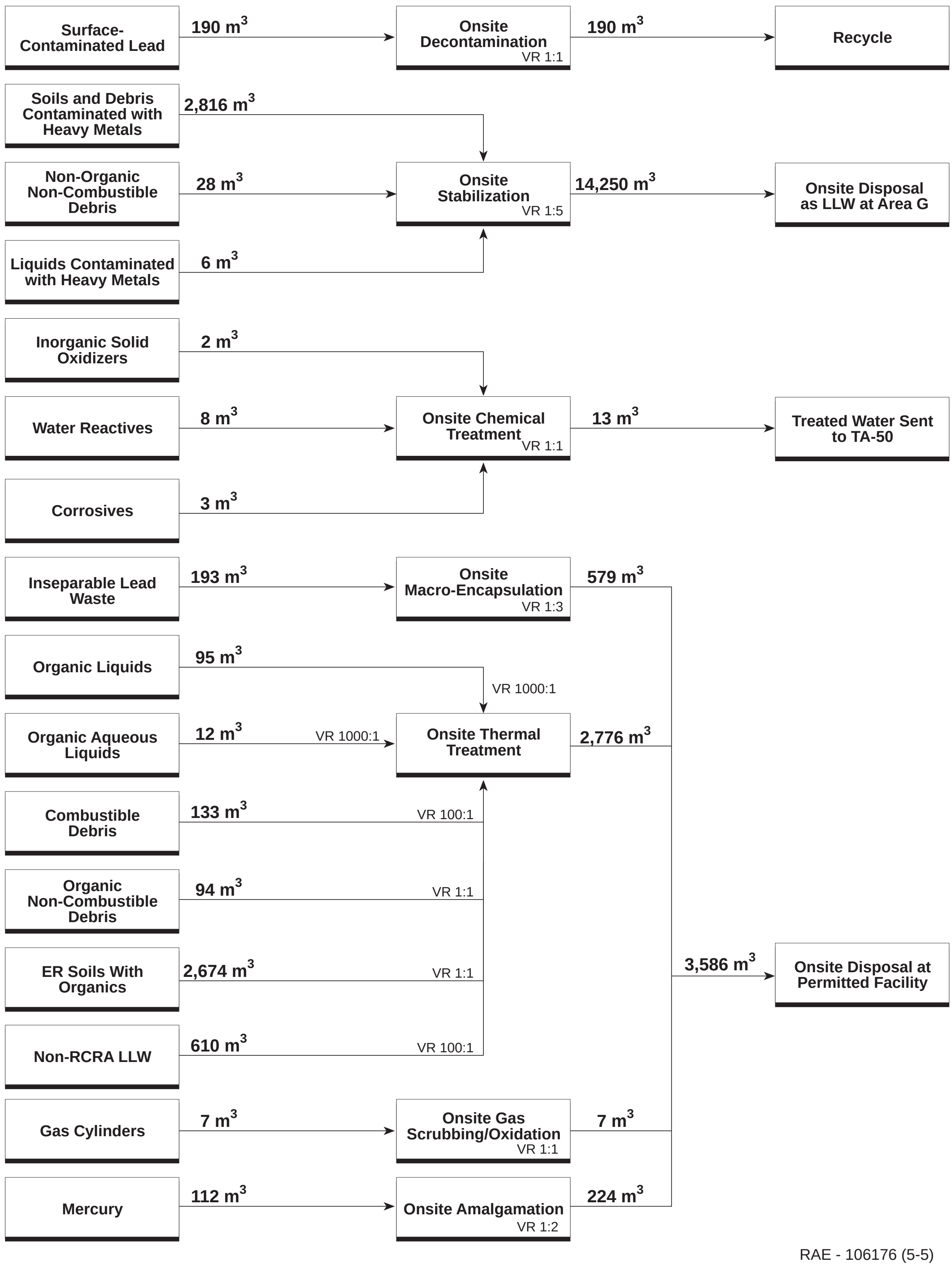

Figure 5-5. Maximum Onsite Strategy for No Action MLLW Volumes.

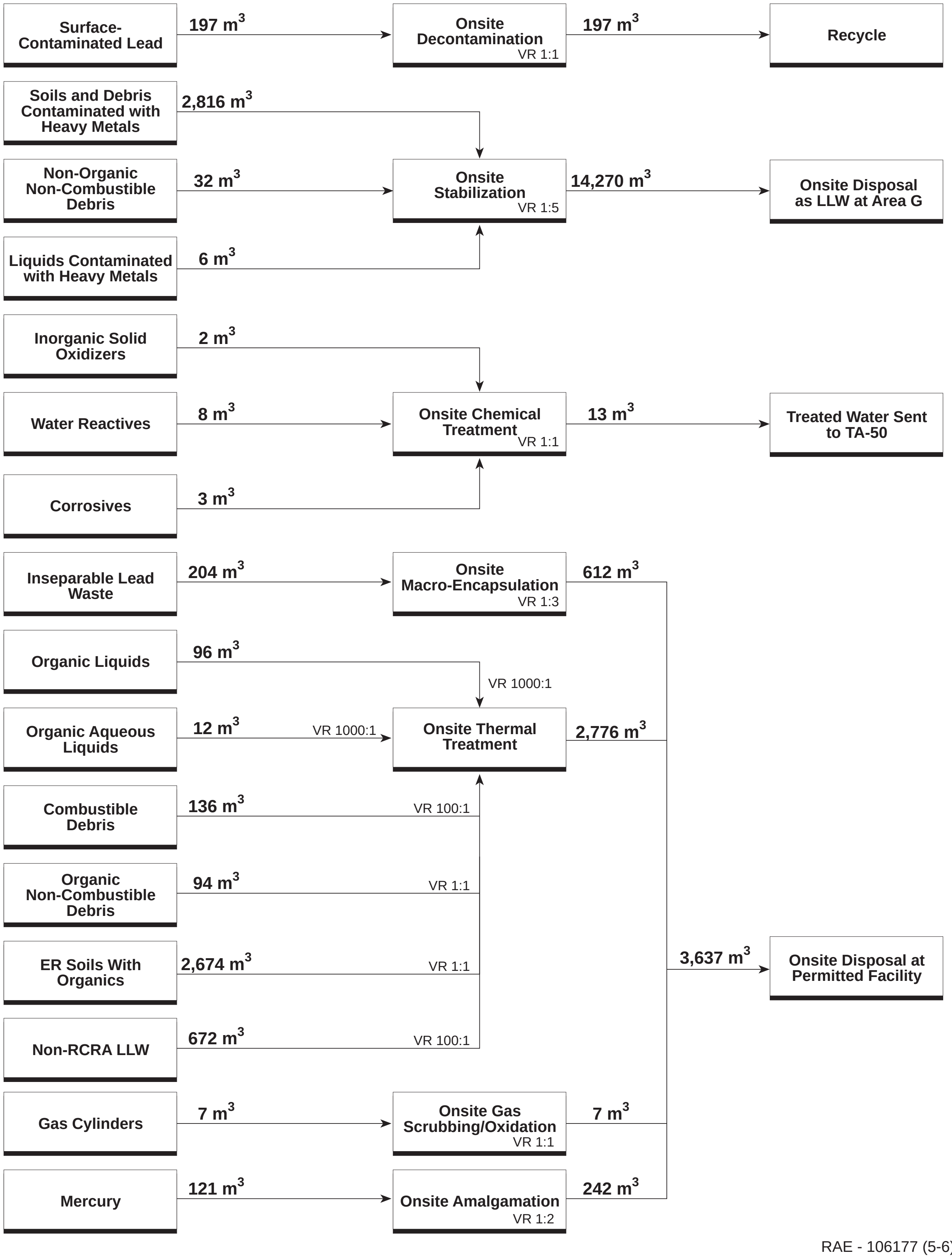

Figure 5-6. Maximum Onsite Strategy for Expanded MLLW Volumes.

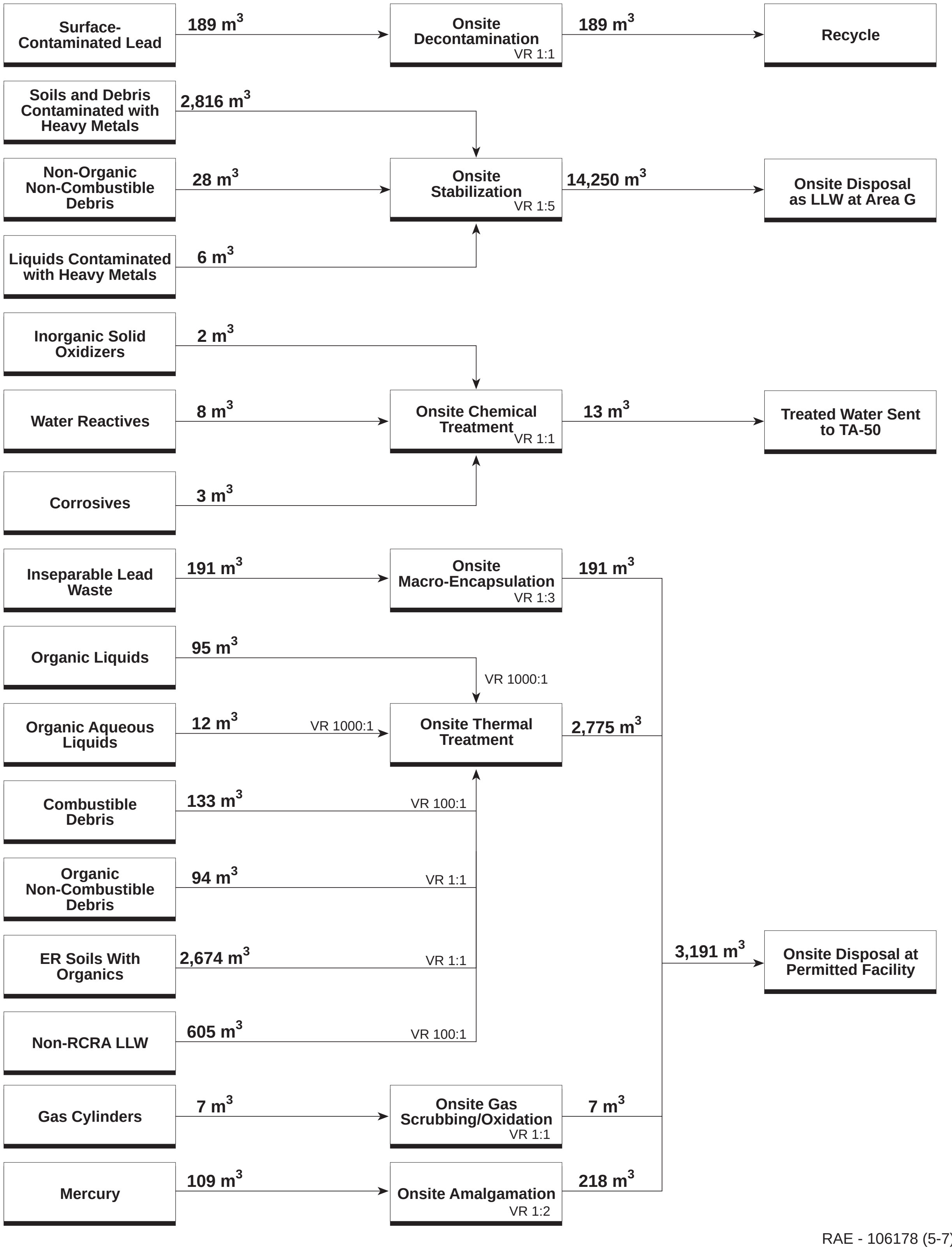

Figure 5-7. Maximum Onsite Strategy for Reduced MLLW Volumes.

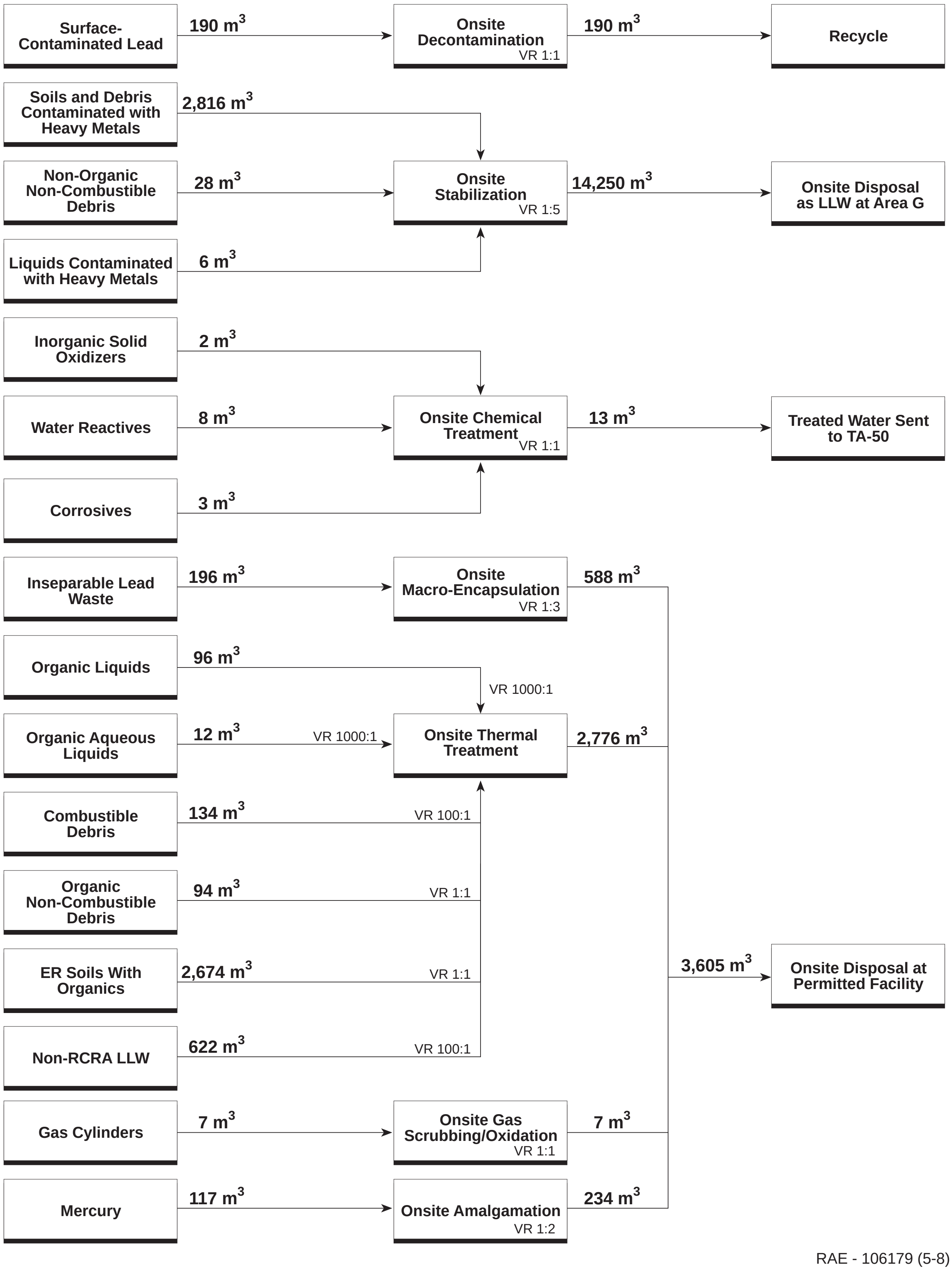

Figure 5-8. Maximum Onsite Strategy for Greener MLLW Volumes.

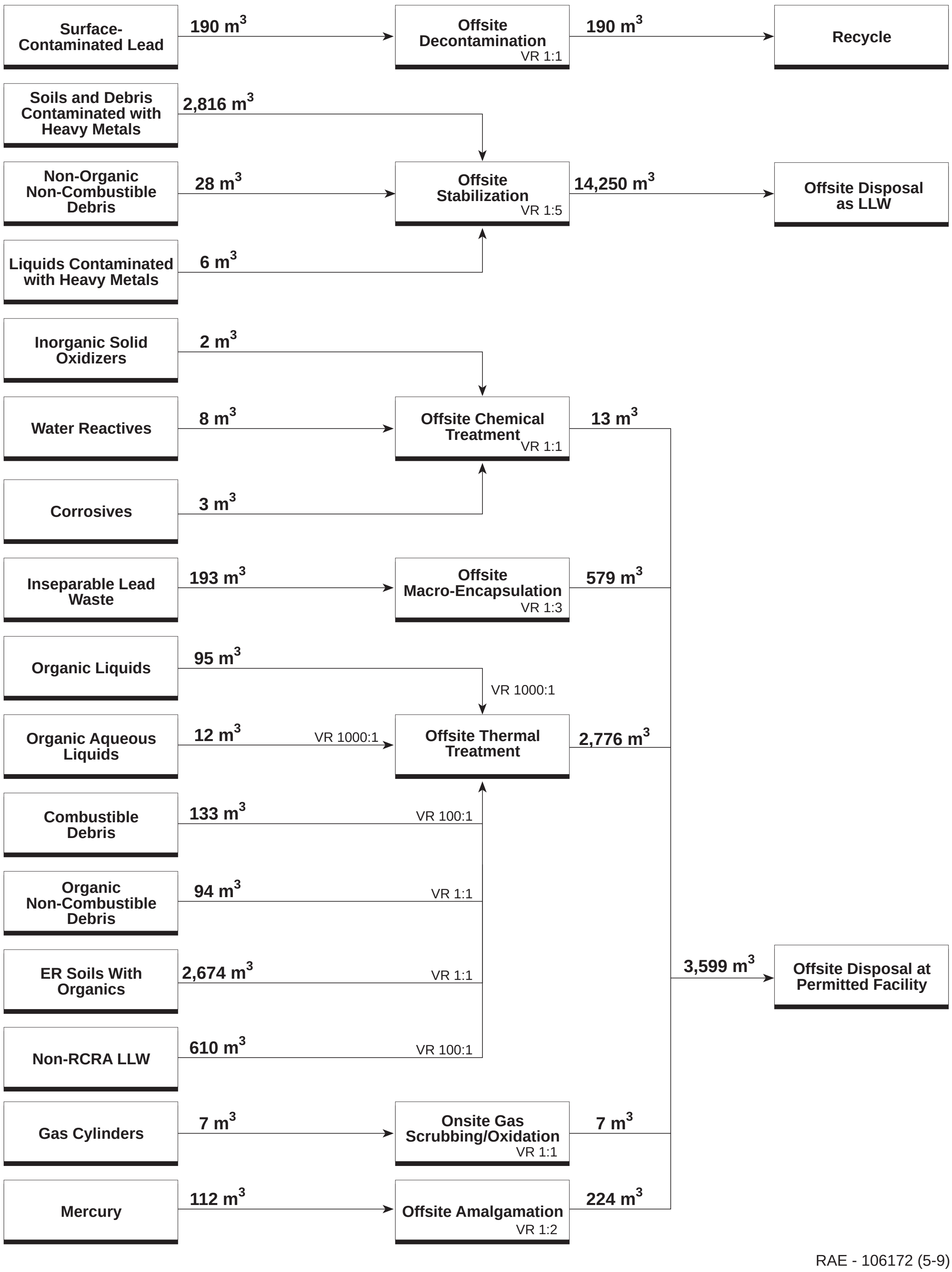

Figure 5-9. Minimum Onsite Strategy for No Action MLLW Volumes.

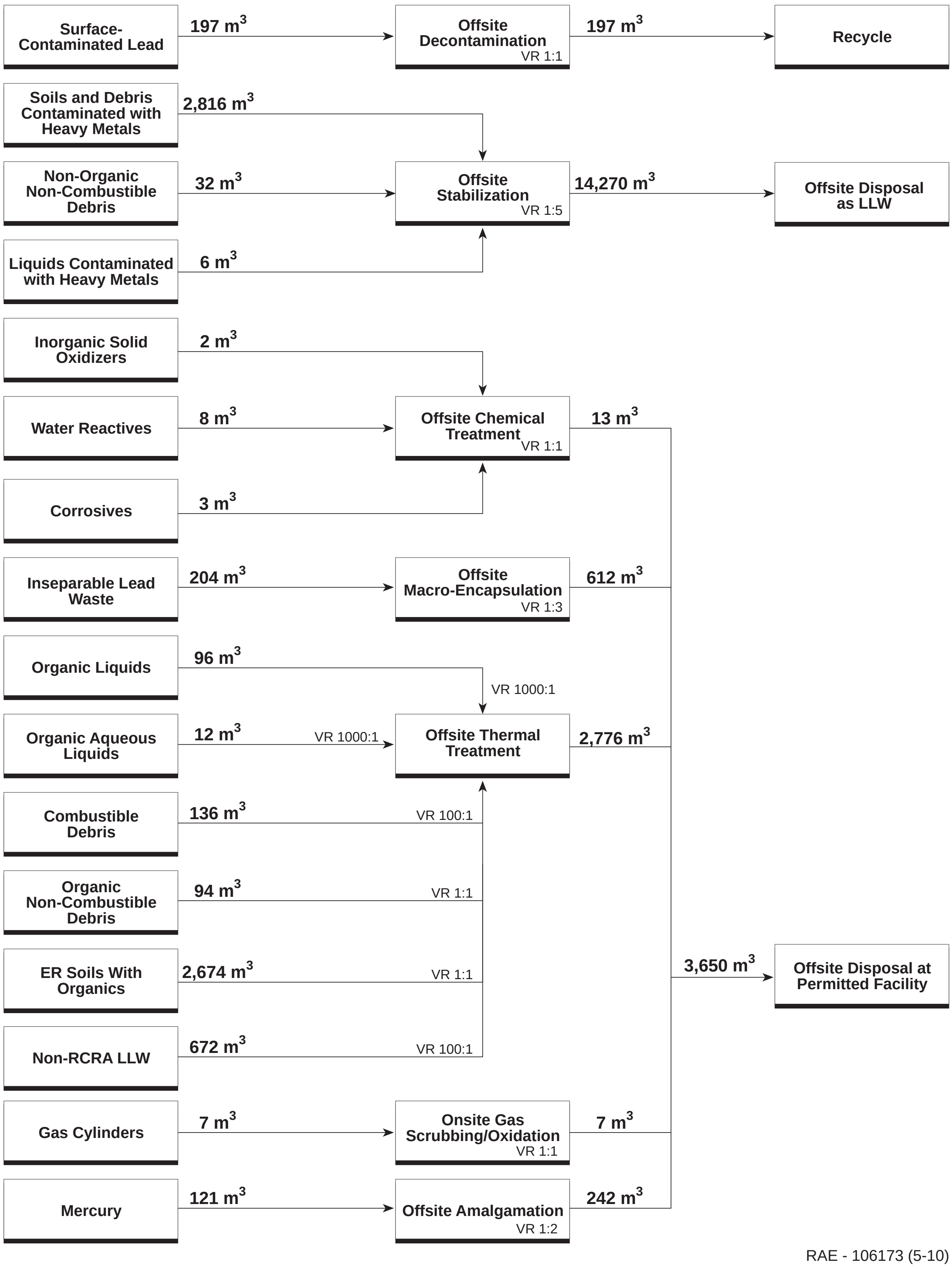

Figure 5-10. Minimum Onsite Strategy for Expanded MLLW Volumes.

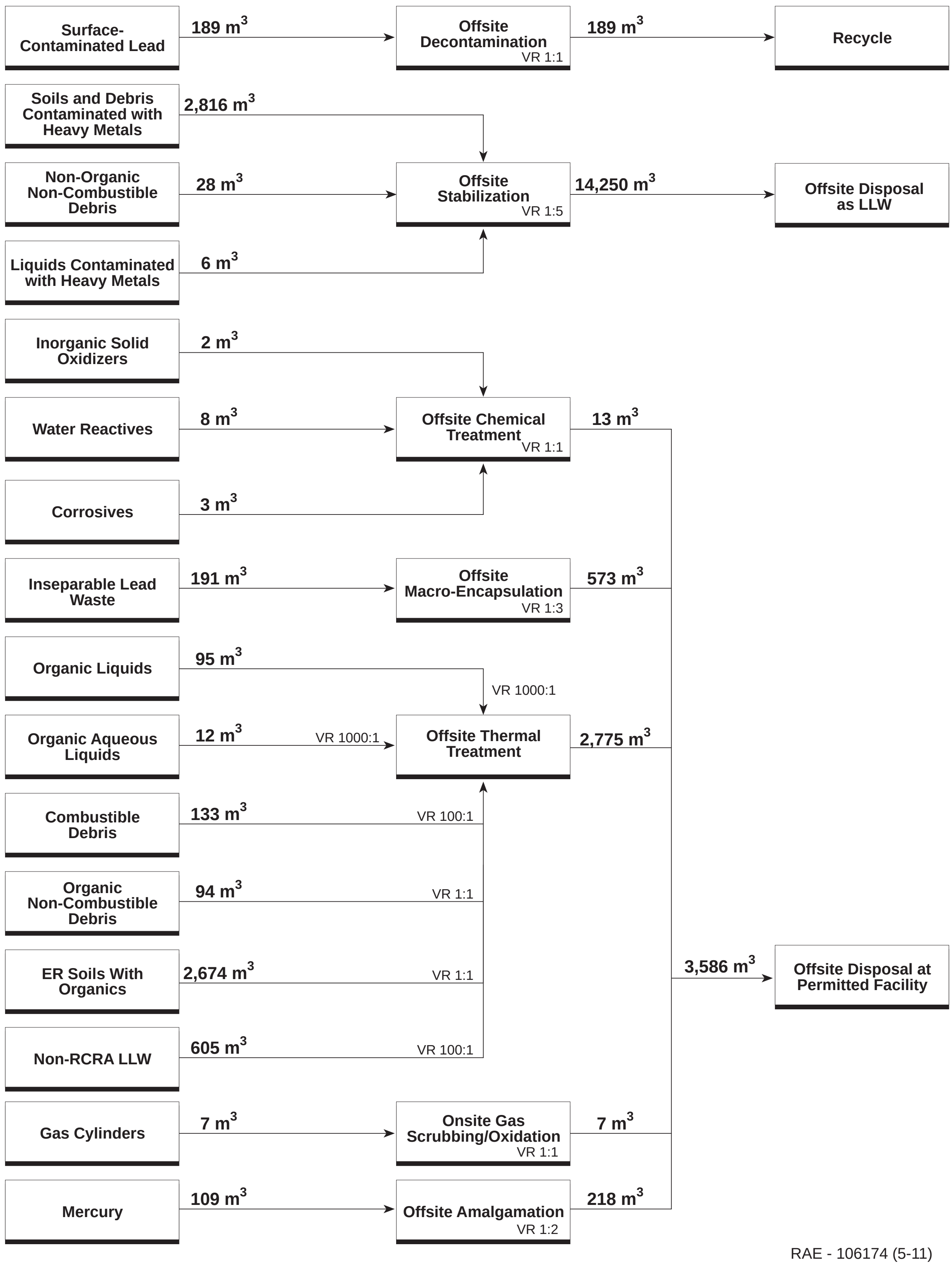

Figure 5-11. Minimum Onsite Strategy for Reduced MLLW Volumes.

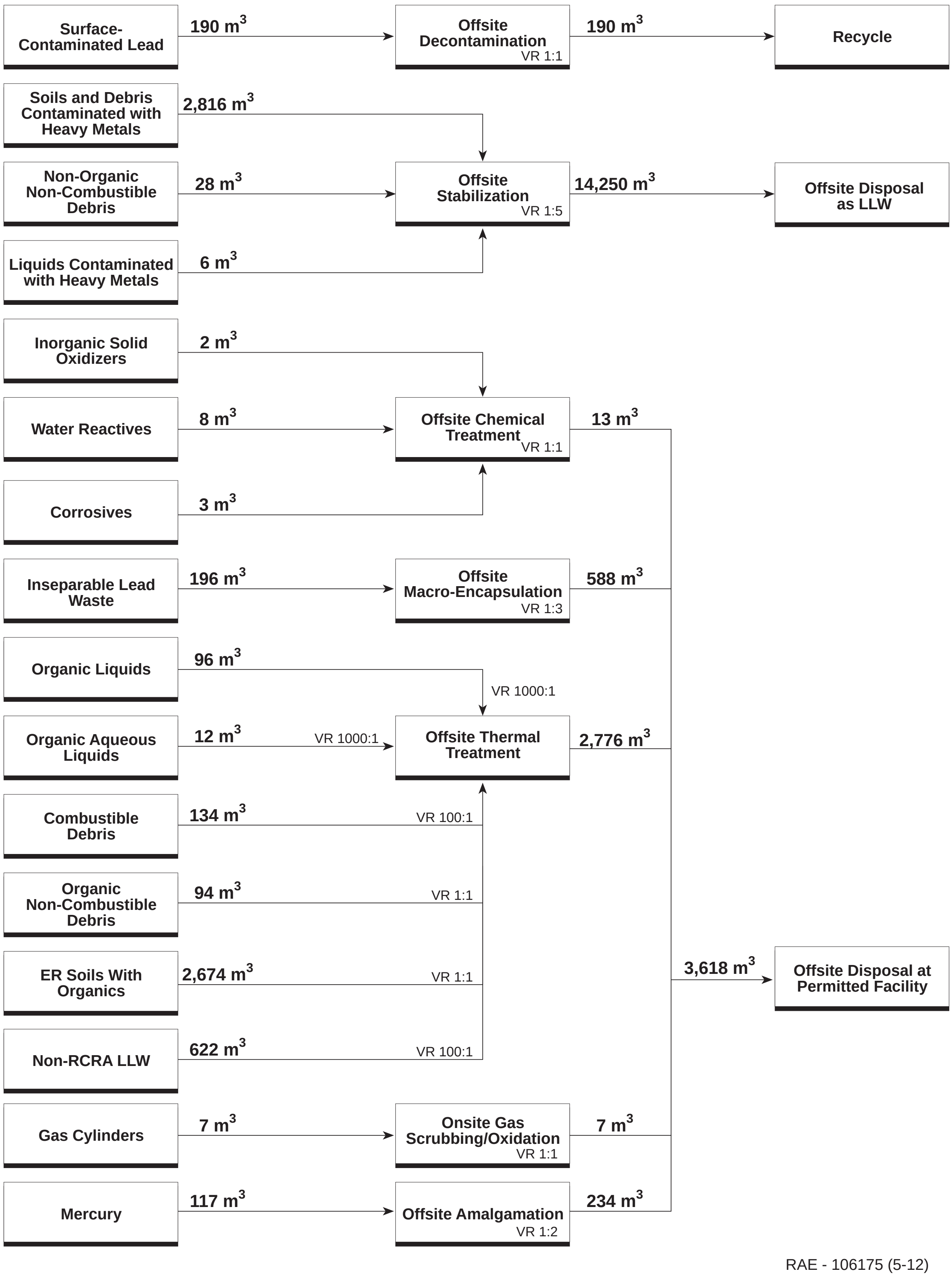

Figure 5-12. Minimum Onsite Strategy for Greener MLLW Volumes.

6. CHEMICAL WASTE MANAGEMENT STRATEGY

This chapter describes the generation rates, characteristics, and management options for chemical waste at LANL. It addresses characterization, treatment, storage, and disposal of LANL's chemical waste, as well as three chemical waste management strategies: Current Path, Maximum Onsite, and Minimum Onsite. The Current Path strategy takes a cost-sensitive approach to evaluating management options and generally follows current waste management plans at LANL. The Maximum Onsite strategy considers management options, including treatment, storage, and disposal, that could be performed and/or developed on site within the 10-year time frame of the SWEIS. In general terms, the Minimum Onsite Strategy focuses on onsite implementation of only those management functions that must occur for waste shipment.

6.1. Chemical Waste Definitions and Description

Chemical waste is hazardous waste that exhibits a hazardous characteristic (ignitability, corrosivity, reactivity, or toxicity), is listed as a hazardous waste by EPA, is a mixture of listed hazardous waste and solid waste, or is a secondary waste associated with the treatment, storage, or disposal of a listed hazardous waste. Chemical waste is subject to regulation under RCRA. For this report, regulated PCB waste and asbestos waste are included in chemical waste, and mixed wastes are not included in chemical wastes.

6.2. Chemical Waste Inventories

Projections of chemical waste generation by LANL operations have been developed in support of the SWEIS (Rogers & Associates Engineering Corporation 1996). The projections provide 10 year waste quantity estimates for the different levels of operations considered under the four SWEIS Alternatives: No Action, Expanded, Reduced, and Greener. The waste projections include contributions from the 13 key LANL facilities, other non key facilities, environmental restoration, and decontamination and decommissioning activities. Other activities will occur at LANL and produce waste over the 10-year time frame but have not yet been sufficiently developed to provide waste projections. These activities include the upgrades associated with the Capabilities, Maintenance, and Improvement Project and the CMR upgrades. The analysis presented here does not include estimates of waste generated by these activities.

The waste projections and their development are described in detail in the SWEIS Waste Projections Data Package (Rogers & Associates Engineering Corporation 1996). The projected chemical waste quantities for the four SWEIS alternatives are summarized, by treatment option, in Table 6-1.

Currently LANL ships all chemical waste off site, and therefore does not strictly track ultimate treatment methodologies and disposal options. Vendors provide these services for a fee and treat and dispose of the waste in a cost-effective, regulation-compliant manner. Because of the long-standing practice of using offsite services, the need has not arisen for developing traditional "Treatability groups," and thus historical data by Treatability group are not readily available. To carry out the analysis for the three chemical waste management strategies, historical records of shipments were acquired. These records indicate where shipments were sent for treatment or where waste was disposed. In most cases, the treatment option could be assumed based on the facility to which the shipment was sent. The analysis focused on five basic groupings of chemical waste: incinerable waste, chemically treated waste, solidified waste, recycled materials, and waste sent directly to landfill.

6.3. Chemical Management Elements

The management of chemical waste at LANL is primarily driven by federal and state regulatory requirements, DOE policies and guidance, funding levels, available cost-effective technologies, and storage and disposal capabilities. Existing management of chemical waste is implemented through the CST Waste Management Facilities Waste Acceptance Criteria and Certification (LANL 1994), and other administrative and detailed operating procedures in place at the generating facilities.

Development of LANL's waste management strategies considered the following elements: characterization, treatment, storage, and disposal. The following sections describe these elements and identify technology options that are available to successfully and effectively implement each waste management strategy.

6.3.1. Characterization

Waste characterization is the process of identifying and quantifying constituents of concern present in a given waste stream. The purpose of waste characterization is to ensure the proper management of wastes in accordance with regulatory classification and requirements and to ensure safe handling, transportation, storage, and disposal of the waste. Characterization techniques that are currently implemented at LANL include (a) AK and (b) sampling and analysis. These characterization techniques are described in the following paragraphs.

6.3.1.1. Acceptable Knowledge

AK refers to information that is used for waste characterization in place of direct sampling and analysis. AK includes process knowledge and previous sampling results associated with the waste. The AK technique involves documenting the raw materials used in a process or operation, the associated material safety data sheets, the products produced, and the associated waste produced. It also involves knowing the facility or process history and all previous and current activities that affect the facility or process that generates the waste. By properly documenting and certifying the AK to be accurate, a generator may then deduce the chemical content, radionuclide content, and physical form of the waste.

6.3.1.2. Sampling and Analysis

Sampling and analysis provide direct and accurate waste characterization information when they are performed in accordance with standard field sampling procedures and on representative waste samples. An effective sampling and analysis routine will include a sampling and analysis plan, sample-handling procedures, and quality assurance and quality control procedures for both field sampling collections and laboratory sample analysis. Sampling and analysis procedures for RCRA constituents comply with EPA techniques specified in EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (EPA 1992), commonly referred to as SW 846.

6.3.2. Treatment

Treatment of chemical waste is driven by RCRA regulations. There are a number of specified treatment technologies that can be employed for various types of chemical waste. Prescribed treatment options for characteristic waste streams (those that exhibit ignitability, corrosivity, reactivity, or toxicity) render the waste non hazardous in a regulatory sense, thus allowing it to be disposed of at a non RCRA-permitted disposal facility. Chemical wastes which contain hazardous constituents that are listed under RCRA (40 CFR 261.D) must be managed under RCRA requirements after treatment. This section discusses treatability groups, treatment options, selection criteria for treatment technologies, and potential impacts of these treatment options should they be implemented on or off site. Onsite treatment for some technologies could be performed at the generator site and/or at a centralized location.

6.3.2.1. Treatability Groups

Chemical waste is categorized in treatability groups, which are based on waste characteristics that affect how the wastes can be treated. Treatability groups were developed based on two parameters: physical and chemical characteristics, and hazardous constituents. Wastes within a treatability group can generally be treated with similar technologies. Wastes in different treatability groups often require different treatment technologies.

The physical and chemical nature of a waste largely determines which technologies are appropriate for its treatment. Wastes were grouped for a particular treatment based on the similarity of their physical and chemical characteristics. Each category of waste includes materials that have unique treatment or handling requirements. For example, elemental mercury is subject to specific RCRA treatment requirements and is categorized as a separate form of liquid waste.

Appropriate treatment technologies for the hazardous constituents of a chemical waste are determined according to regulatory or technical feasibility criteria. The primary categories of hazardous wastes are listed wastes and characteristic wastes. Some wastes may show attributes of both waste types. Based on hazardous content, most wastes have specific regulatory requirements for treatment, storage, and disposal. Regulatory drivers are RCRA and TSCA.

RCRA defines hazardous wastes as hazardous because of their quantity, concentration, or physical and chemical characteristics. Hazardous waste includes waste that may pose a substantial present or future hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Materials regulated under TSCA include PCBs and asbestos. The presence of these contaminants invokes specific requirements on the management of waste. PCB contaminated materials are subject to treatment standards that specify stringent destruction and removal efficiencies.

6.3.2.2. Screening Process for Treatment Technology Selection

Selection criteria for treatment of a given waste stream are based on the technical feasibility of destroying the hazardous constituents of the waste, removing the hazardous constituent, or immobilizing the hazardous constituent. Selection is also based on treatment requirements of RCRA.

6.3.2.3. Treatment Options Selected

The majority of LANL chemical waste can be managed by incineration, chemical treatments, recycling, or stabilization. Each of these treatment options is described in section 5.3.2.7 of Chapter 5.

6.3.3. Storage

Only short-term staging of chemical waste has been required for LANL chemical wastes. Historically, commercial providers of waste storage have been able to make regular pick-ups such that storage capacities have been adequate. However, for the Maximum Onsite strategy, storage capacity would have to be developed in the event that offsite vendors were not used during the time period in which onsite treatment technologies were being developed.

6.3.4. Disposal

The ultimate disposition of chemical waste is disposal. Currently, chemical waste generated at LANL is disposed off site. Disposal options exercised by LANL at this time are limited to commercial, RCRA-permitted service providers. This section discusses current and potential offsite disposal locations as well as an onsite chemical waste disposal facility.

6.3.4.1. Onsite Disposal Facility

Onsite disposal of chemical waste would be dependent on the development of MWDF. Should an MWDF be developed at LANL, an appropriate number of cells could be designated for chemical waste disposal. Section 5.3.4.1 of Chapter 5 discusses this disposal facility.

6.3.4.2. Offsite Disposal

Offsite disposal options include commercial facilities. There are a large number of offsite providers. In general, waste is treated and disposed of at the same facility. When combined, the services offered by these facilities could allow offsite disposal of all the chemical waste generated at LANL. All offsite waste shipments would require adherence to the facility's waste acceptance criteria and compliance with DOT regulations.

6.4. Chemical Waste SWEIS Strategies

Three different chemical waste management strategies have been developed based on DOE direction: Current Path, Maximum Onsite, and Minimum Onsite. Section 6.4.1 presents the viable TSD options for chemical waste management and describes how they are implemented in the three chemical waste strategies. Sections 6.4.2, 6.4.3, and 6.4.4 discuss the application of the strategies to the waste volumes resulting from the four SWEIS alternatives. Section 6.4.5 summarizes and compares each of the alternatives.

6.4.1. Strategies Development and Assumptions

Table 6-2 lists the TSD capabilities that are applicable to the management of chemical waste at LANL. The table indicates which option will be exercised and by whom for each of the three strategies. Capabilities were selected for each of the three strategies based on DOE guidance to create the Maximum Onsite and Minimum Onsite strategies. The Maximum Onsite and Minimum Onsite scenarios were developed by DOE with the goal of encompassing and describing the range of possible management options. Thus, an optimistic assumption was made that the appropriate treatment and disposal options for managing chemical waste on site could be developed within the 10 year time frame of the SWEIS.

6.4.2. Current Path Strategy

The Current Path strategy reflects the activities that LANL is currently funded to perform. The selection of options is the culmination of DOE policy, budgetary limitations, and the existence of offsite capabilities. No onsite treatment or disposal activities are proposed for this strategy. The management of chemical waste by well-proven commercial vendors has been a long-standing option that has been exercised across the DOE complex. Figures 6-1 through 6-4 indicate the waste flow by treatment or disposal destination for the four SWEIS alternatives: No Action, Expanded, Reduced, and Greener. Table 6-3 summarizes the total chemical waste projected mass and the ultimate destination of wastes for the Current Path strategy when applied to the LANL SWEIS alternative waste quantities.

As shown in the tables and flow charts, waste quantities generated under the four LANL SWEIS alternatives do not change the strategy elements or waste flow under the Current Path strategy. For the Current Path strategy it was assumed that shipments will be managed at a centralized location.

6.4.3. Maximum Onsite Strategy

The Maximum Onsite strategy assumes that LANL will manage all the chemical waste it generates. This strategy puts forth all the elements that would need to occur on site for LANL to accomplish this goal. It would involve the development and permitting of a number of treatment technologies as well as the siting, permitting, and construction of both an incinerator and MWDF, with cells allocated for chemical waste disposal. Development of these technologies would require extensive planning, development, costs, and commitment of time and effort. The rationale for development of this model involves applying the same technologies that are applied by offsite facilities and moving them onsite. An important linkage among these elements is that between developing an incinerator and a disposal site. Both facilities are included in this strategy because it would not be efficient to have one without the other. If there were no onsite incinerator, LANL waste would need to be shipped off site for incineration and then shipped back to be disposed of on site. On the other hand, if there were an incinerator without onsite disposal capability, incinerated waste would still need to be shipped off site for disposal. In either case, the local environmental impacts would increase without the benefit of a cost and risk savings achieved by avoiding waste transportation.

Figures 6-5 through 6-8 indicate the waste flow by treatment for the four LANL SWEIS alternatives: No Action, Expanded, Reduced, and Greener. Table 6-4 summarizes the total chemical waste projected mass and the ultimate destination of wastes for the Maximum Onsite strategy when applied to the LANL SWEIS alternative waste quantities.

As shown in the tables and flow charts, waste quantities generated under the four LANL SWEIS alternatives do not change the strategy elements or waste flow under the Maximum Onsite strategy. At this point, all treatment technologies selected as onsite options would require RCRA permits, which LANL does not possess at this time. For the Maximum Onsite strategy it was assumed that all of the treatment capabilities will be managed at a centralized location.

6.4.4. Minimum Onsite Strategy

The Minimum Onsite strategy is essentially the same as the Current Path strategy. The only operational difference is that it assumes that the generators will be responsible for shipping their waste off site. Under this strategy there is no centralized storage or shipping capability. One potential drawback of this scenario is that there would be a greater potential for violation of the 90-day storage rule if an offsite shipment were canceled or delayed. Also, there would be more immediate potential closure issues for Area L.

Figures 6-9 through 6-12 indicate the waste flow by treatability group for the four LANL SWEIS alternatives: No Action, Expanded, Reduced, and Greener. Table 6-5 summarizes the total chemical waste projected mass and the ultimate destination of wastes for the Minimum Onsite strategy when applied to the LANL SWEIS alternative waste quantities.

As shown in the tables and flow charts, waste quantities generated under the four LANL SWEIS alternatives do not change the strategy elements or waste flow under the Minimum Onsite strategy. For the Minimum Onsite strategy it was assumed that shipments will be managed by the generator.

6.5. Strategies Comparison

Tables 6-6 through 6-9 summarize quantities of waste flow by SWEIS alternative for each of the three chemical waste management strategies. Waste quantities do not influence decisions regarding what strategy elements will be implemented on site as opposed to off site under any model. The overriding decision criterion was to create the Maximum Onsite and Minimum Onsite strategies. Further, distributions of waste stream treatability groups were not found to vary significantly across the alternatives. As shown, there is not a significant difference between the Minimum Onsite strategy and the Current Path strategy.

Table 6-1. 10-year cumulative chemical waste inventories for the four SWEIS alternatives.

Treatability Group	No Action (thousand kg)	Expanded (thousand kg)	Reduced (thousand kg)	Greener (thousand kg)
Incineration	6,000	6,800	6,000	6,000
Chemical treatment	370	410	370	370
RCRA-permitted disposal	12,700	14,000	12,700	12,700
Non-RCRA-permitted disposal	9,200	10,300	9,100	9,200
Recycling	400	450	400	400
Generator tank storage	150	170	150	150
TOTAL	28,820,000	32,130,000	28,720,000	28,720,000

Table 6-2. Implementation matrix for CTSD options and chemical waste management strategies.

CTSD Capability	Current Path	Maximum Onsite	Minimum Onsite
Characterization			
Acceptable knowledge	Generator site	Generator site	Generator site
Sampling and analysis	Generator site and/or centralized on site	Generator site and/or centralized on site	Generator site
Treatment			
Incineration	Off site	On site	Off site
Chemical treatments	Off site	On site	Off site
Solidification	Off site	On site	Off site
Recycling	Off site and on site	On site	Off site
Storage			
Area L domes	Used	Used	Not used
Generator site (< 90 days)	Used	Used	Used
Disposal			
RCRA-permitted	Off site	Onsite	Off site
Non-RCRA-permitted	On site and off site	On site	Off site

Table 6-3. Composite disposition of chemical waste inventories under the Current Path strategy.

SWEIS Alternative	Waste Quantity (thousand kg)	Disposition (thousand kg)	
No Action	28,820	6,150	Incineration and offsite disposal
		370	Chemical treatment and offsite disposal
		12,700	RCRA-permitted disposal
		9,200	Non-RCRA-permitted disposal
		400	Recycling
Expanded	32,130	6,970	Incineration and offsite disposal
		410	Chemical treatment and offsite disposal
		14,000	RCRA-permitted disposal
		10,300	Non-RCRA-permitted disposal
		450	Recycling
Reduced	28,720	6,150	Incineration and offsite disposal
		370	Chemical treatment and offsite disposal
		12,700	RCRA-permitted disposal
		9,100	Non-RCRA-permitted disposal
		400	Recycling
Greener	28,820	6,150	Incineration and offsite disposal
		370	Chemical treatment and offsite disposal
		13,700	RCRA-permitted disposal
		9,200	Non-RCRA-permitted disposal
		400	Recycling

Table 6-4. Composite disposition of chemical waste inventories under the Maximum Onsite strategy.

SWEIS Alternative	Waste Quantity (thousand kg)	Disposition (thousand kg)	
No Action	28,820	6,150	Incineration
		370	Chemical treatment
		38,285	Onsite RCRA-permitted chemical treatment and disposal
		9,570	Onsite non-RCRA-permitted disposal
		400	Recycling
Expanded	32,130	6,970	Incineration
		410	Chemical treatment
		42,209	Onsite RCRA-permitted chemical treatment and disposal
		10,710	Onsite non-RCRA-permitted disposal
		450	Recycling
Reduced	28,720	6,150	Incineration
		370	Chemical treatment
		38,285	Onsite RCRA-permitted chemical treatment and disposal
		9,470	Onsite non-RCRA-permitted disposal
		400	Recycling
Greener	28,820	6,150	Incineration
		370	Chemical treatment
		38,285	Onsite RCRA-permitted chemical treatment and disposal
		9,570	Onsite non-RCRA-permitted disposal
		400	Recycling

Table 6-5. Composite disposition of chemical waste inventories under the Minimum Onsite strategy.

SWEIS Alternative	Waste Quantity (thousand kg)	Disposition (thousand kg)	
No Action	28,820	6,150	Incineration and offsite disposal
		370	Chemical treatment and offsite disposal
		12,700	RCRA-permitted disposal
		9,200	Non-RCRA-permitted disposal
		400	Recycling
Expanded	32,130	6,970	Incineration and offsite disposal
		410	Chemical treatment and offsite disposal
		14,000	RCRA-permitted disposal
		10,300	Non-RCRA-permitted disposal
		450	Recycling
Reduced	28,720	6,150	Incineration and offsite disposal
		370	Chemical treatment and offsite disposal
		12,700	RCRA-permitted disposal
		9,100	Non-RCRA-permitted disposal
		400	Recycling
Greener	28,820	6,150	Incineration and offsite disposal
		370	Chemical treatment and offsite disposal
		12,700	RCRA-permitted disposal
		9,200	Non-RCRA-permitted disposal
		400	Recycling

Table 6-6. Waste flows for the three MLLW strategies applied to No Action chemical waste volumes.

Capability	Current Path (thousand kg)	Maximum Onsite (thousand kg)	Minimum Onsite (thousand kg)
Characterization	28,820	28,820	28,820
Treatment			
Onsite treatment	0	19,220	0
Offsite treatment	6,520	0	6,520
Storage	Variable to capacity	Variable to capacity	Variable to capacity
Disposal			
Disposed by treatment facility	6,520	0	6,520
Offsite RCRA-permitted	12,700	0	12,700
Onsite RCRA-permitted	0	38,285	0
Offsite non-RCRA-permitted	6,900	0	9,200
Onsite non-RCRA-permitted	2,300	9,570	0
Recycling	400	400	400

Table 6-7. Waste flows for the three MLLW strategies applied to Expanded chemical waste volumes.

Capability	Current Path (thousand kg)	Maximum Onsite (thousand kg)	Minimum Onsite (thousand kg)
Characterization	32,130	32,130	32,130
Treatment			
Onsite treatment	0	21,380	0
Offsite treatment	7,380	0	7,380
Storage	Variable to capacity	Variable to capacity	Variable to capacity
Disposal			
Disposed by treatment facility	7,380	0	7,380
Offsite RCRA-permitted	14,000	0	14,000
Onsite RCRA-permitted	0	42,209	0
Offsite non-RCRA-permitted	7,725	0	10,300
Onsite non-RCRA-permitted	2,575	10,710	0
Recycling	450	450	450

Table 6-8. Waste flows for the three MLLW strategies applied to Reduced chemical waste volumes.

Capability	Current Path (thousand kg)	Maximum Onsite (thousand kg)	Minimum Onsite (thousand kg)
Characterization	28,720	28,720	28,720
Treatment			
Onsite treatment	0	19,220	0
Offsite treatment	6,520	0	6,520
Storage	Variable to capacity	Variable to capacity	Variable to capacity
Disposal			
Disposed by treatment facility	6,520	0	6,520
Offsite RCRA-permitted	12,700	0	12,700
Onsite RCRA-permitted	0	38,285	0
Offsite non-RCRA-permitted	6,825	0	9,100
Onsite non-RCRA-permitted	2,275	9,470	0
Recycling	400	400	400

Table 6-9. Waste flows for the three MLLW strategies applied to Greener chemical waste volumes.

Capability	Current Path (thousand kg)	Maximum Onsite (thousand kg)	Minimum Onsite (thousand kg)
Characterization	28,820	28,820	28,820
Treatment			
Onsite treatment	0	19,220	0
Offsite treatment	6,520	0	6,520
Storage	Variable to capacity	Variable to capacity	Variable to capacity
Disposal			
Disposed by treatment facility	6,520	0	6,520
Offsite RCRA-permitted	12,700	0	12,700
Onsite RCRA-permitted	0	38,285	0
Offsite non-RCRA-permitted	6,900	0	9,200
Onsite non-RCRA-permitted	2,300	9,570	0
Recycling	400	400	400

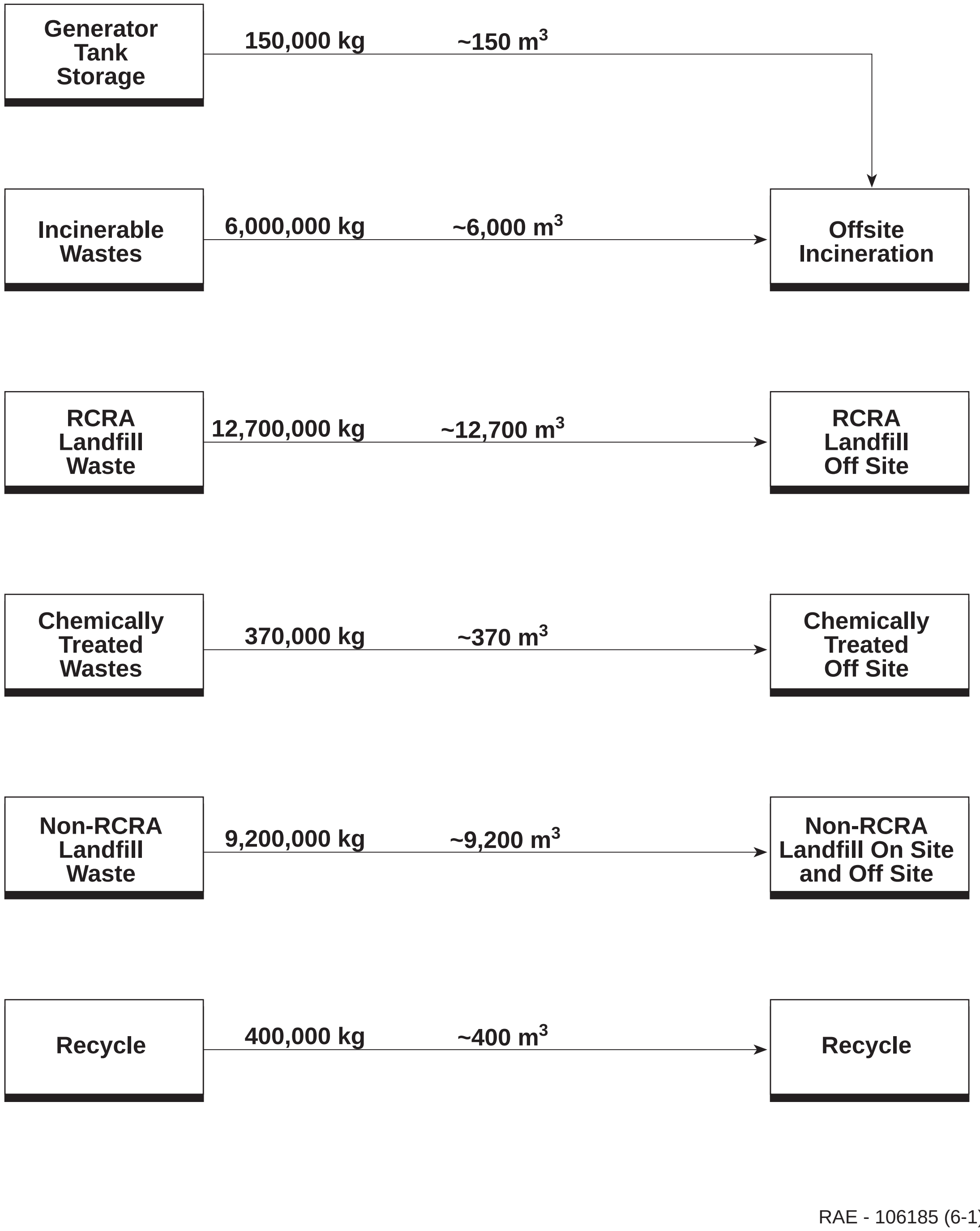

Figure 6-1. Current Path Strategy for No Action Chemical Waste Volumes.

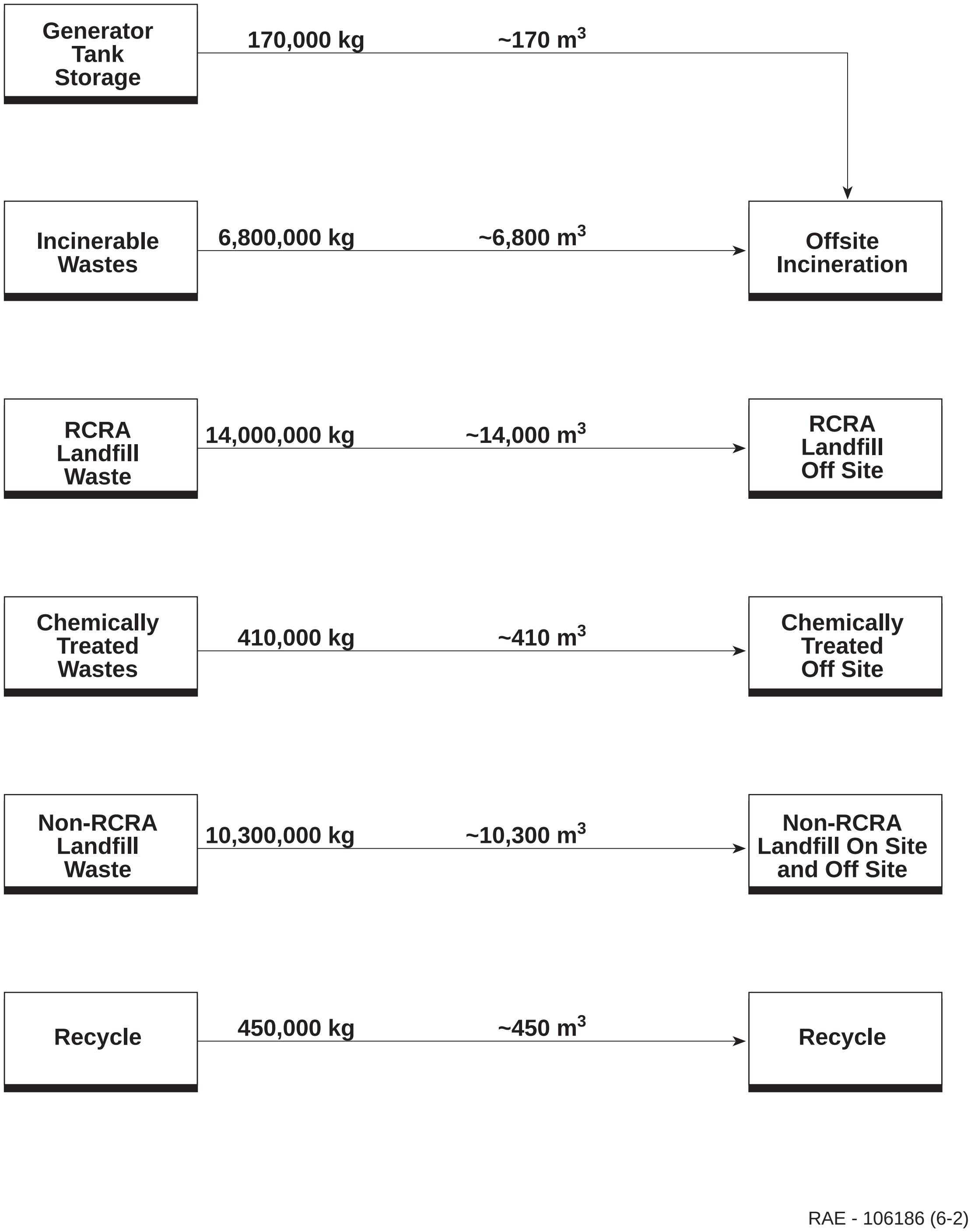

Figure 6-2. Current Path Strategy for Expanded Chemical Waste Volumes.

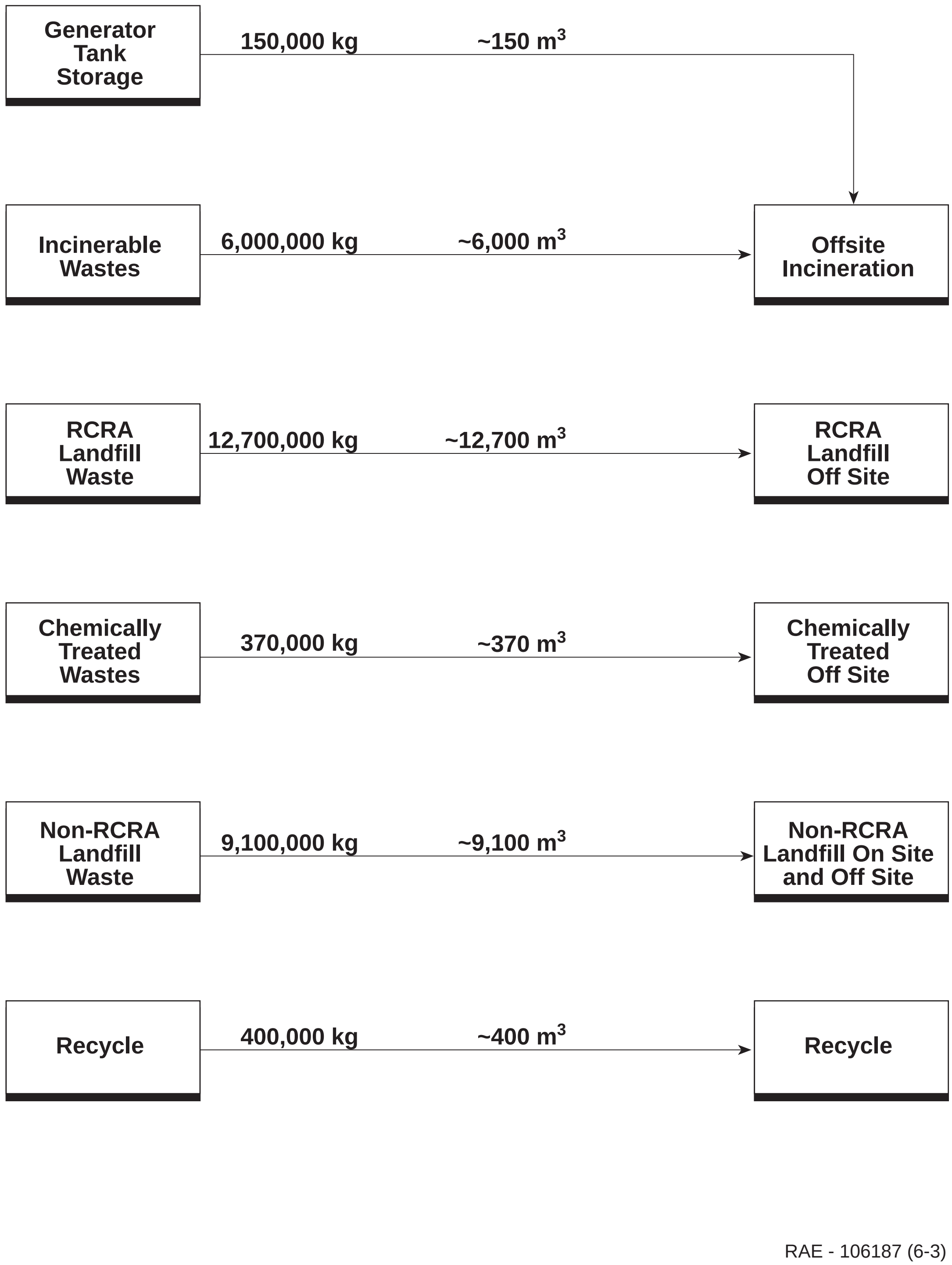

Figure 6-3. Current Path Strategy for Reduced Chemical Waste Volumes.

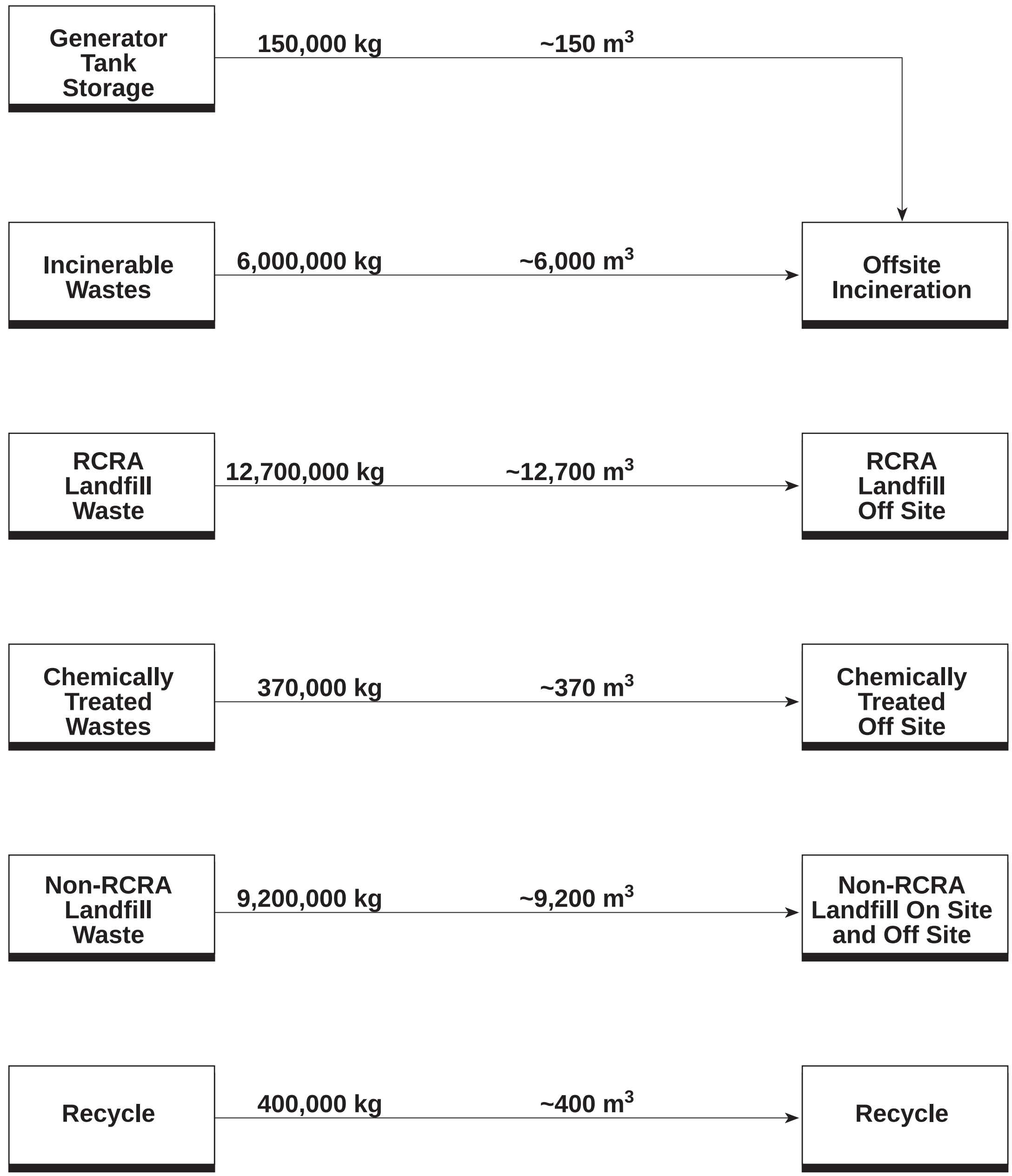

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Figure 6-4. Current Path Strategy for Greener Chemical Waste Volumes.

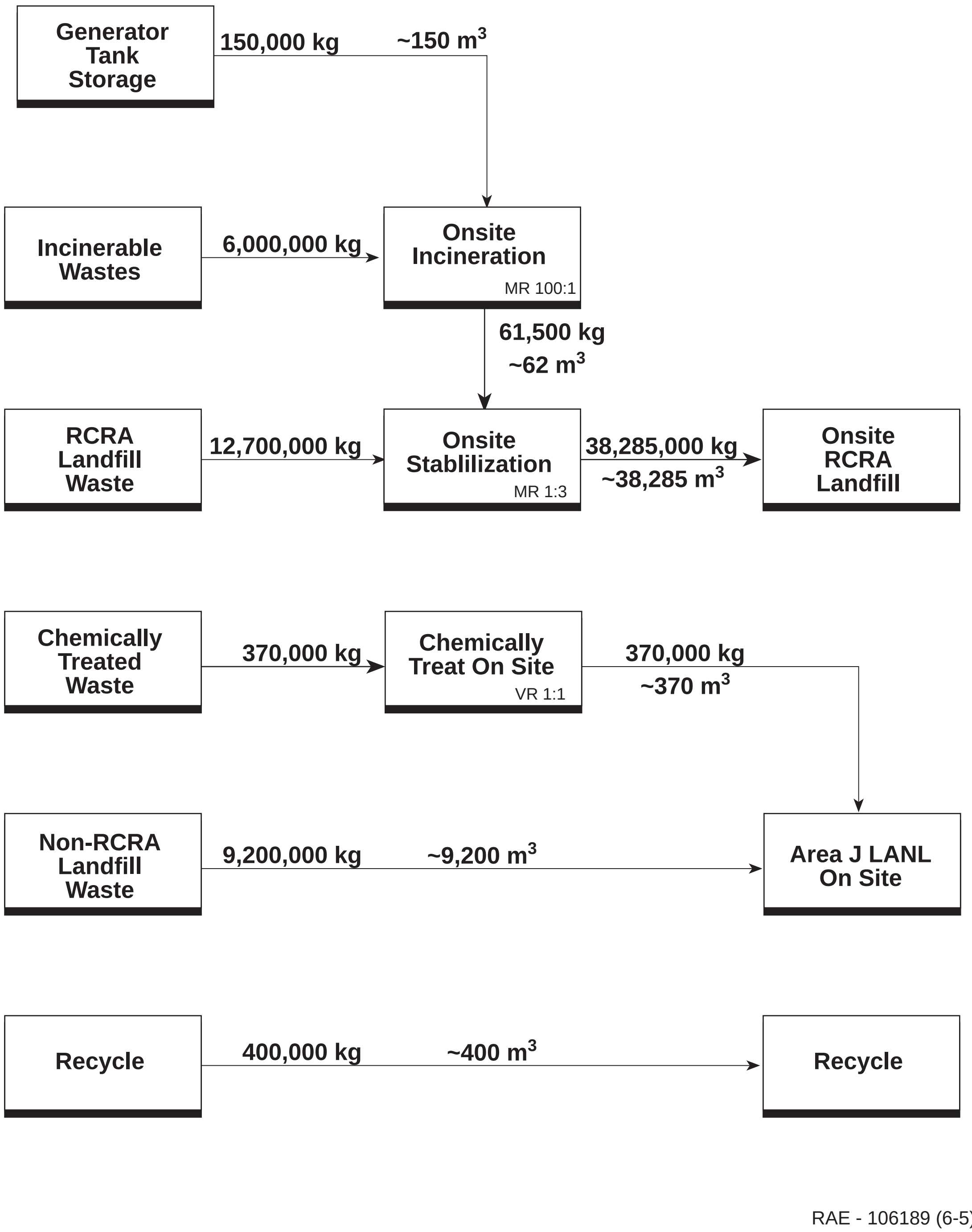

Figure 6-5. Maximum Onsite Strategy for No Action Chemical Waste Volumes.

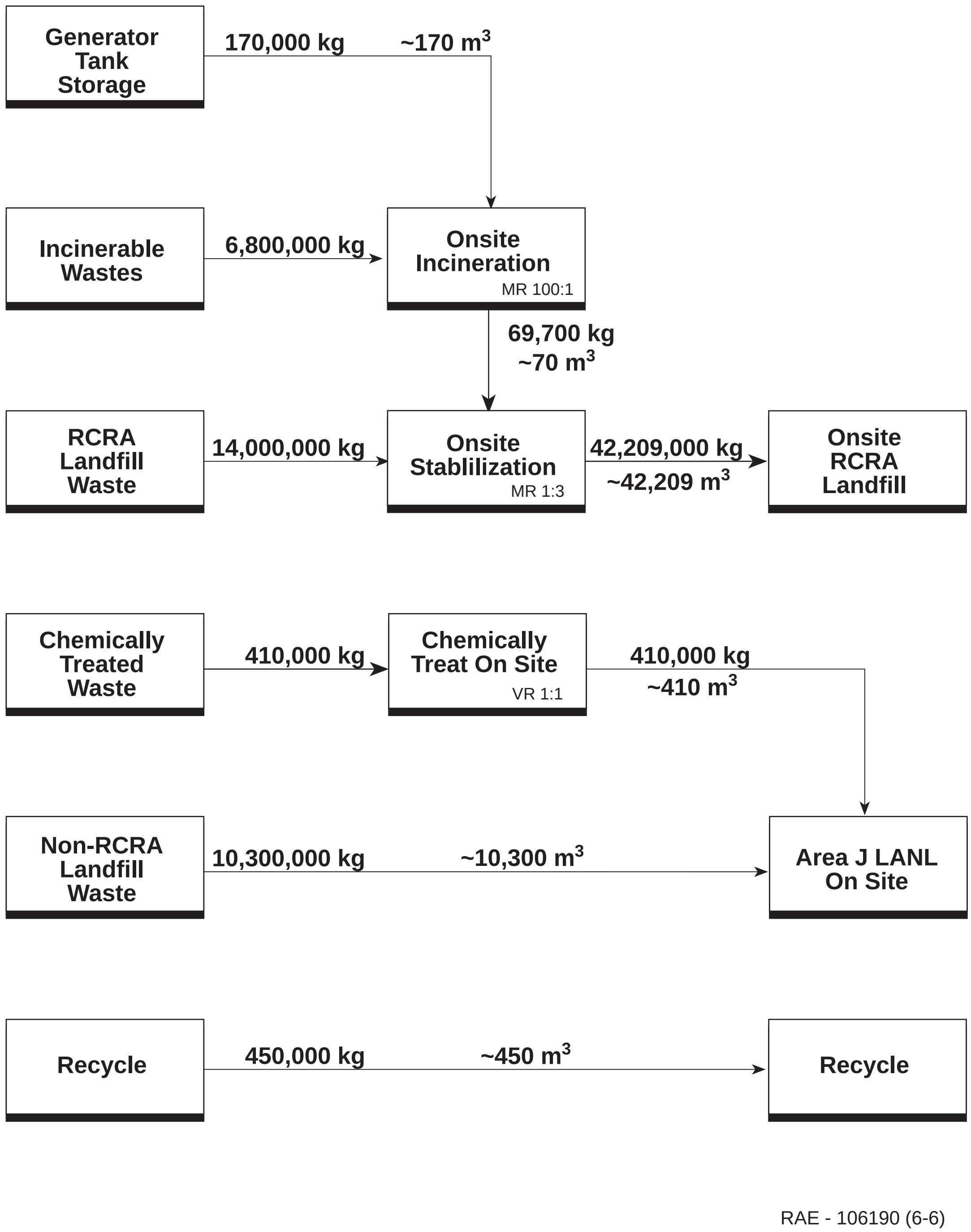

Figure 6-6. Maximum Onsite Strategy for Expanded Chemical Waste Volumes.

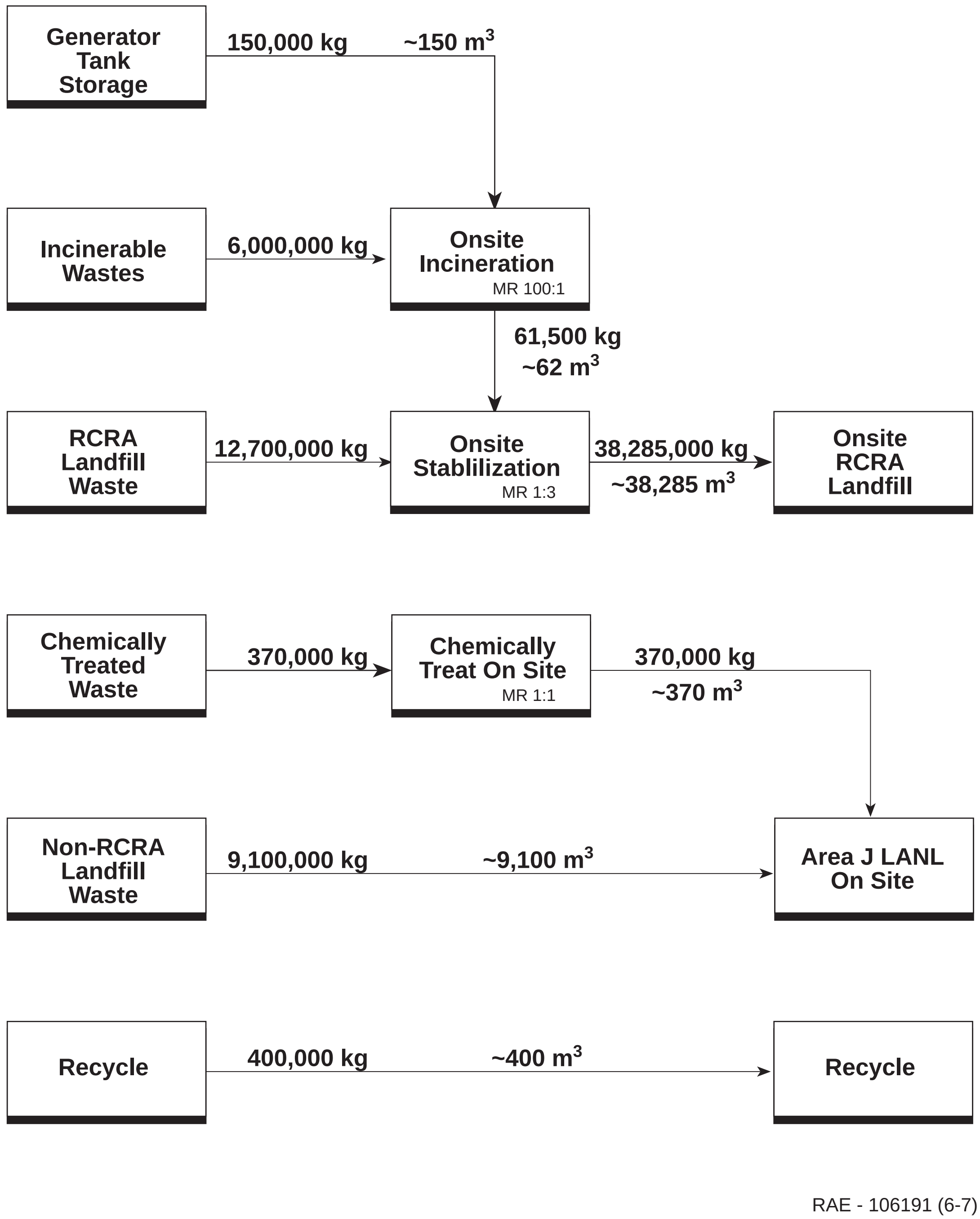

Figure 6-7. Maximum Onsite Strategy for Reduced Chemical Waste Volumes.

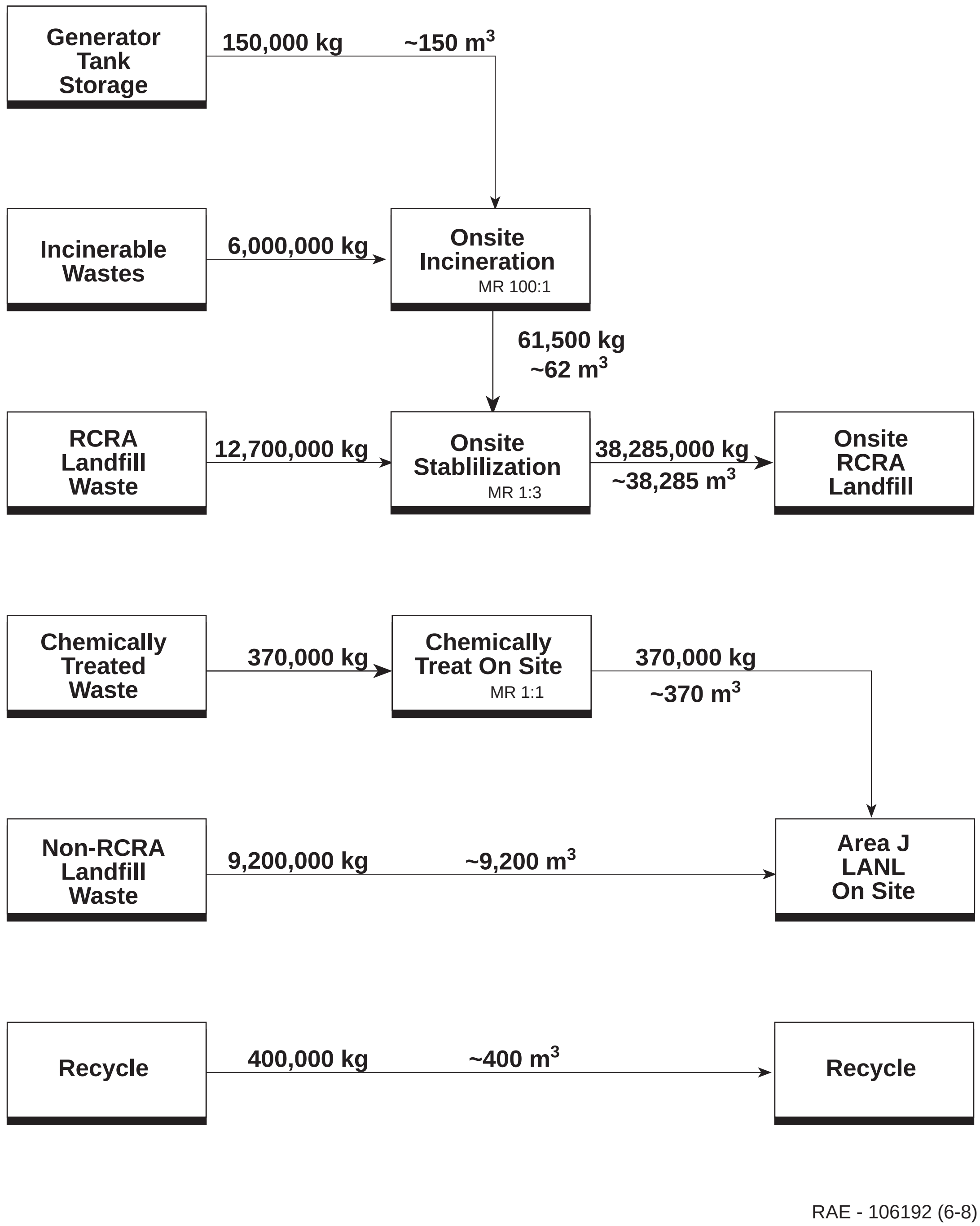

Figure 6-8. Maximum Onsite Strategy for Greener Chemical Waste Volumes.

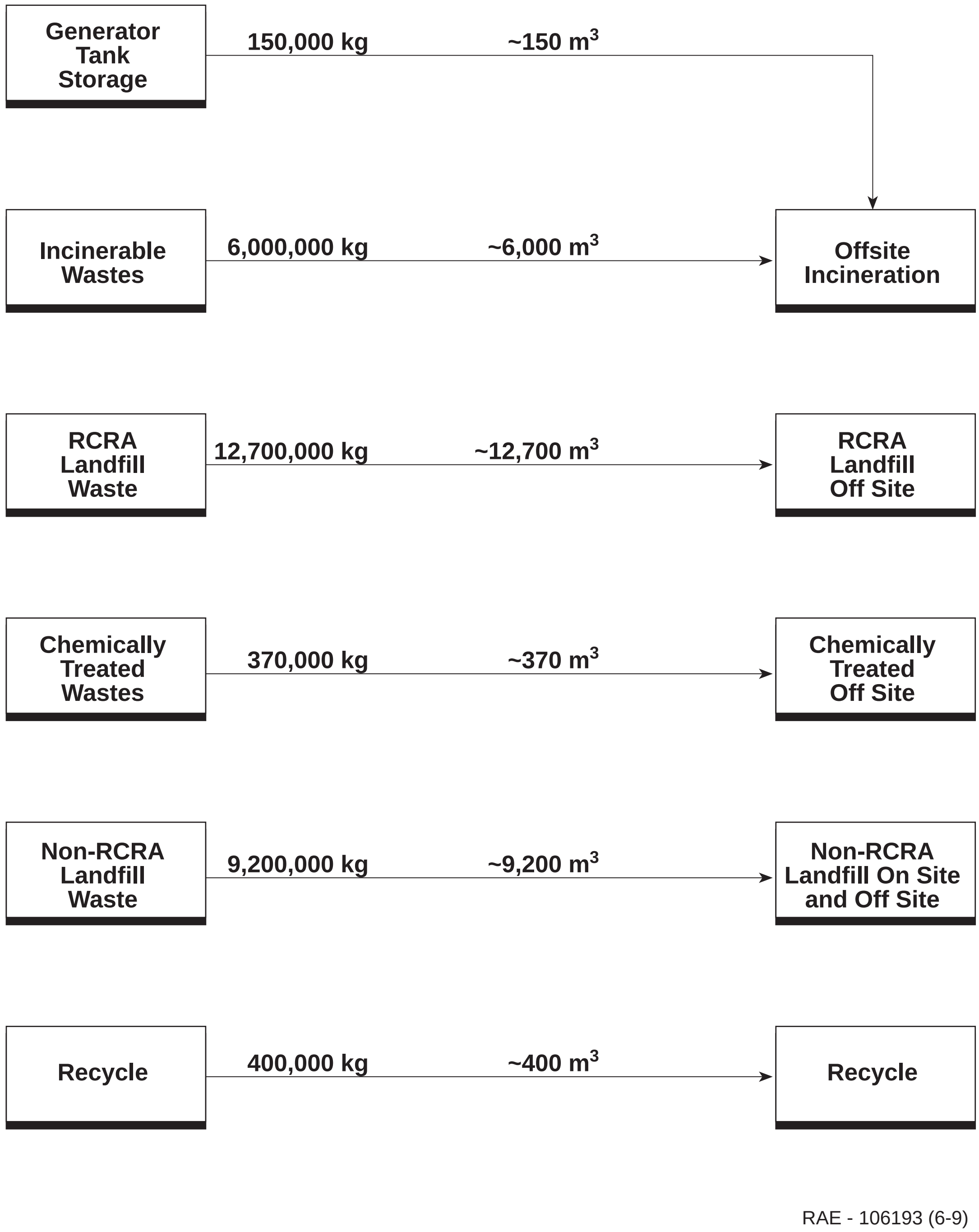

Figure 6-9. Minimum Onsite Strategy for No Action Chemical Waste Volumes.

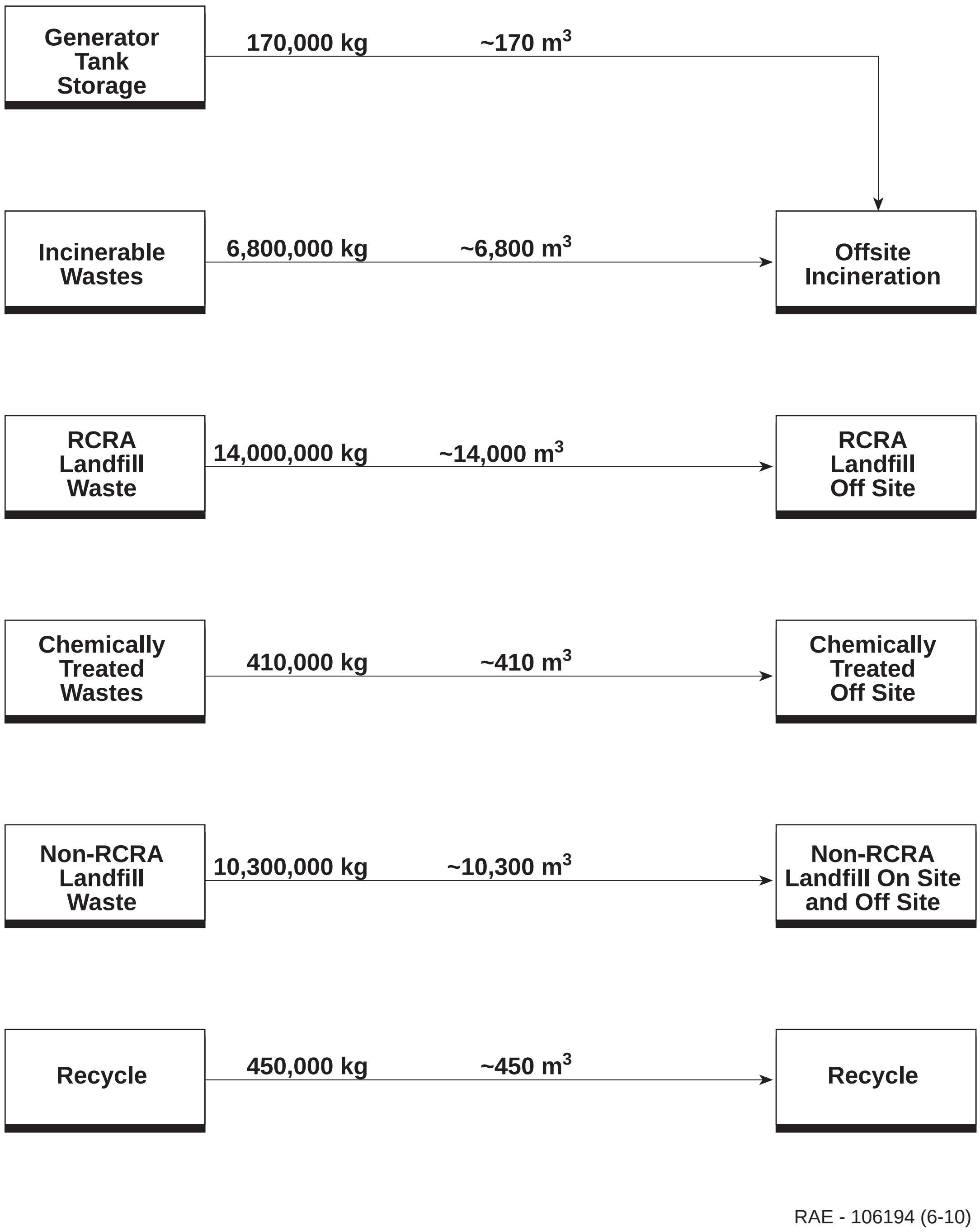

Figure 6-10. Minimum Onsite Strategy for Expanded Chemical Waste Volumes.

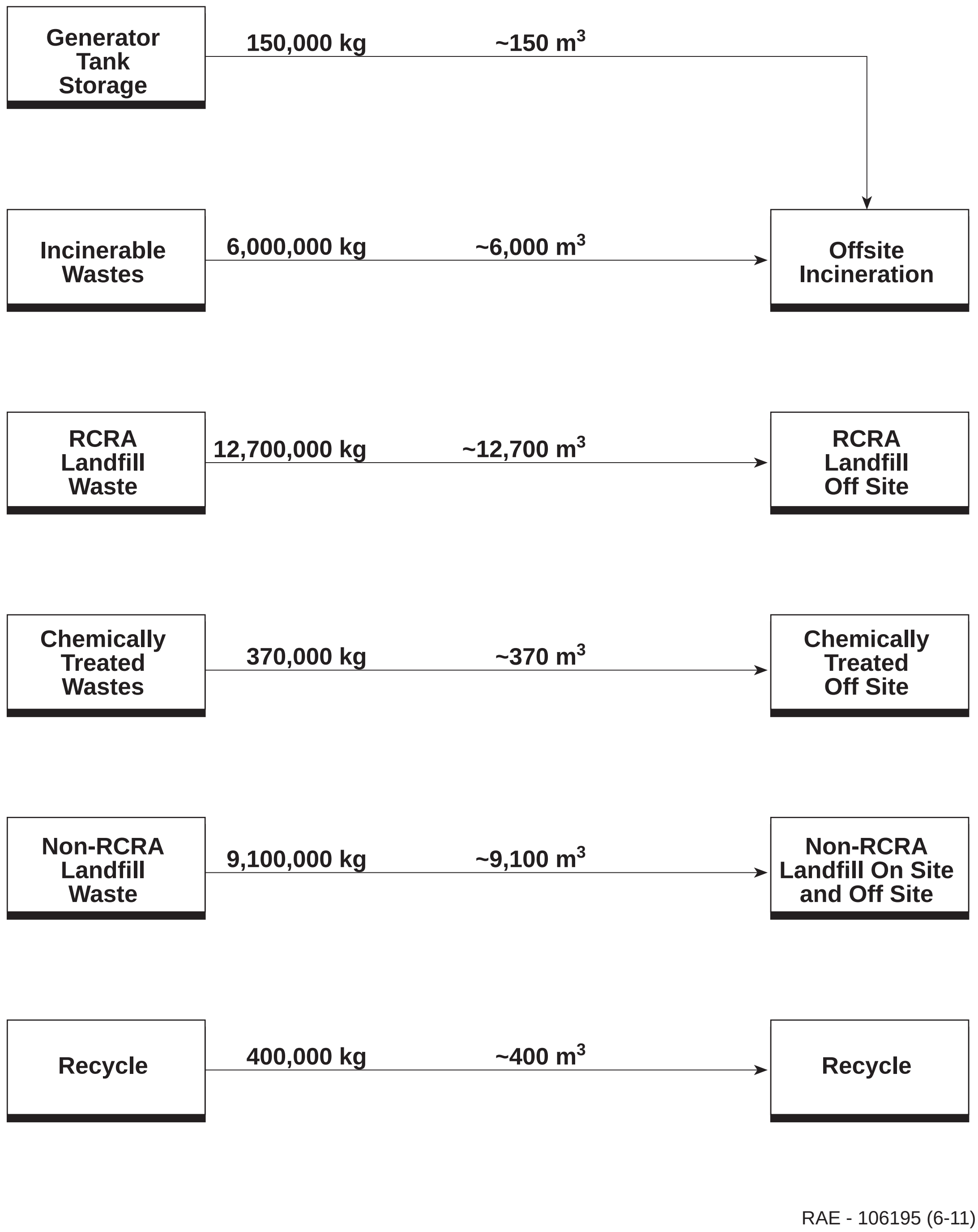

Figure 6-11. Minimum Onsite Strategy for Reduced Chemical Waste Volumes.

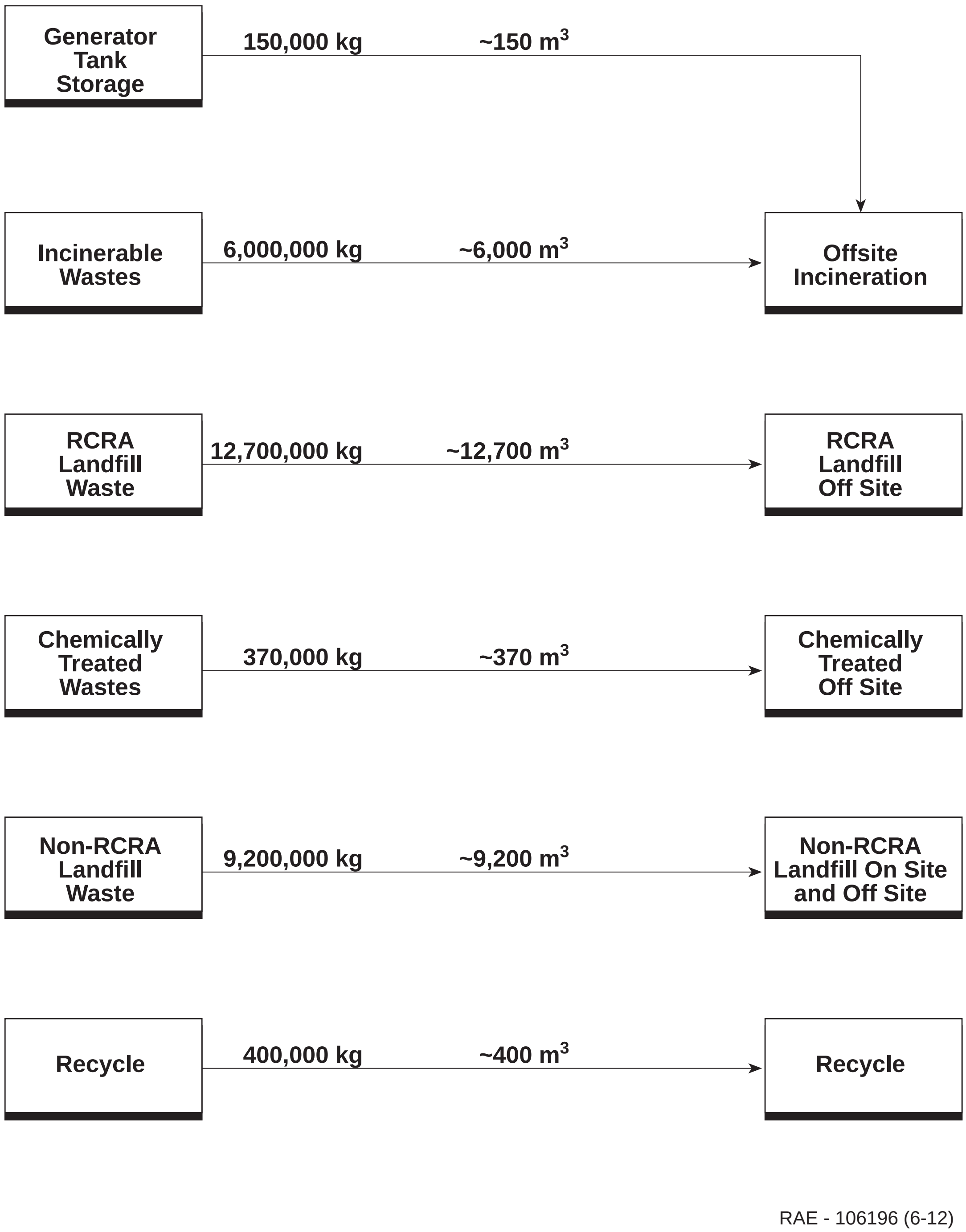

Figure 6-12. Minimum Onsite Strategy for Greener Chemical Waste Volumes.

7. RADIOACTIVE LIQUID WASTE MANAGEMENT STRATEGY

7.1. RLW Definitions and Description

RLW is generated from a variety of chemistry laboratory and production activities conducted at 17 different facilities. The majority of the liquid waste streams are transferred by direct pipeline between the generator and treatment facilities. The remaining liquid waste streams from a few facilities are transferred via truck transport to the main treatment facility. A simplified flow diagram showing the waste collection system and processing facilities is shown in Figure 7-1.

RLW currently is treated at two onsite facilities. The first facility is the main RLWTF, which is located at TA-50. A second treatment facility is located at TA-21 and treats limited quantities of RLW on an as-needed basis from buildings located within TA-21 in which chemistry laboratory, and decommissioning and decontamination activities are conducted. The treated effluent from TA-21 is transferred via pipeline to TA-50 for additional treatment in the RLWTF.

7.2. RLW Inventories

7.2.1. Influent Character

Because the RLWTF receives aqueous waste from a large number of generators, the waste water characteristics vary widely throughout the year. There are both radioactive and non-radioactive contaminants in the waste water which require treatment. Based on chemical and radiological measurements of a large number of influent samples, typical radioactive contaminants and concentrations in the waste water influent are provided in Tables 7-1; typical non-radioactive constituents and their concentrations are shown in Table 7-2.

7.2.2. Influent Quantity

An influent-design-basis study was completed as part of an overall evaluation to select the best demonstrated available technology for the treatment of LANL RLW. The study was intended to establish the basis for the waste water volumes to be treated and the radioactive and non-radioactive contaminants typically contained in the waste.

The values in the study for these design basis parameters were derived from:

- Operating data.
- Sampling and analysis results.
- Generator questionnaires.

In the study, the average daily influent waste volume was calculated using data from three different time intervals: a 10-year span from 1985 to 1994; a 2-year span from 1985 to 1987, when Pu activity at TA-55 was high; and the year 1994. The average flow rates during these periods were 79,000 L/d, 98,000 L/d, and 42,000 L/d, respectively. The design value selected for Phase I treatment process is 60,000 liters/day as an approximate mean value for the three time frames evaluated. The peak plant capacity was selected as 80,000 L/d, which translates to 20.8 million L/yr. The influent-design-basis volume is based on the assumption that the RLWTF will operate 8 hours per day, 5 days per week, with an operating efficiency of 85 percent. Table 7-3 shows volumes from the major generators contributing influent to the RLWTF. Note: TA-55 operated at minimal levels in 1995. The volumes in Table 7-3 do not reflect historical percentages of TA-50 influent volume.

7.3. RLW Management Elements

7.3.1. Present RLWTF

The main RLWTF is being modified to address current and anticipated effluent discharge requirements for treated water. TA-50, Building 1, represents a dedicated facility that will continue to collect and treat LANL liquid flows. Since its construction almost 40 years ago, the RLWTF has used a coprecipitation process in combination with sedimentation and filtration to remove most radioactive constituents from liquid waste before discharging the liquid to the environment. However, operating data from the current treatment process on the removal efficiencies for TRU radionuclides indicate that the derived concentration guides (DCGs) implemented in 1990 by DOE Order 5400.5, Radiation Protection of the Public and the Environment (DOE 1990), are exceeded based on average annual concentrations for AM-241, Pu-238, and Pu-239. The liquid discharges do meet the current NPDES permit conditions, however, the State of New Mexico has proposed a surface water nitrate limit for the renewal of the NPDES permit in 1998 that cannot be met by the current treatment process. The State has also requested a groundwater discharge plan for the RLWTF to meet all state groundwater standards, including the current nitrate standard, which at this time cannot be met by the current system.

In response to this situation, the LANL RLWTF engineering staff is implementing a two-phased plan to introduce new liquid waste treatment processes to replace the current treatment process. Phase I focuses on the short term and involves installing a process system to treat the liquid waste to ensure that the DCG values are not exceeded on an average annual basis. Phase II focuses on the long term and involves installing a system that would treat the liquid waste to (a) ensure that the DCG values are not exceeded and (b) meet both the proposed lower NPDES nitrate discharge limit and the groundwater nitrate limit. The two-phased approach brings the RLWTF effluents into compliance with the DCGs in an expedited manner, while providing time to complete the engineering studies and design for the full treatment system. During Phase I, the plan is to procure ultrafiltration and reverse osmosis equipment on transportable skids and install them along with the other system modifications in Rooms 70, 71, and 72 of Building 1. This first phase should allow the liquid effluent discharges to meet the DOE DCGs, but would not bring the discharges into compliance with the anticipated lower nitrate discharge limits. A simplified flow diagram of the Phase I treatment process is presented in Figure 7-1.

7.3.2. Nitrate Reduction

The second phase of the RLWTF upgrade includes an engineering evaluation of the following three options for treating reverse osmosis concentrates to remove nitrates:

- Ion exchange.
- Biodenitrification.
- Thermal drying.

The selected treatment option would be engineered and implemented in Phase II.

The Phase I process equipment will be installed in existing space at Building 1 at TA-50. The Phase II treatment equipment would be installed either in another existing room (e.g., Room 34B of Building 1) or in a new process building. The Phase I equipment installed in Building 1 could be moved to the new process building if this configuration would be more efficient.

7.3.3. Solids/Effluent Management

Hydraulic flow values and sludge production rates for the LANL SWEIS alternatives can be estimated using the following principal references:

- RLWTF Influent Design Basis Report (Merrick & Company et al. 1995).
- Engineering Evaluation Report (VANCE et al. 1996).

The 1995 report surveyed LANL RLW generators and compared projected operations to historical flow data. More recently, the DOE report evaluated several new unit processes to reduce sludge production rates and meet more stringent discharge standards for the facility.

Both studies provide a useful starting point for estimating flow levels for various SWEIS alternatives, but further assumptions and adjustments are warranted to reflect SWEIS assumptions. While both studies include flow contributions from Stockpile Stewardship initiatives, some of the specific SWEIS operational thresholds differ from these values.

Table 7-4 presents appropriate influent and effluent flow values for each SWEIS alternative. Both the influent design basis and DOE studies estimated future RLW flows to average about 20 million L/yr (5 million gal./yr), which corresponds closely to the historical average for the period 1985-1995. Statistical analysis of flow variations in the 1995 study indicate that the estimated maximum flow will be higher than the 20 million L/yr average flow by about 20 percent, or 25 million L/yr. For the SWEIS No Action and Greener alternatives, this maximum influent flow value represents a reasonable and slightly conservative flow value for the collective RLW influent flow to the RLWTF. For the Reduced alternative, the average influent value of 20 million L/yr would be more appropriate. For the Expanded alternative, the maximum influent value should be adjusted to reflect the increased level and range of operations that are included in this scenario. Using the difference between the influent- design-basis flow and the maximum flow as an indicator, the estimated flow for the Expanded alternative should be increased by 40 percent. This represents an overall influent flow of about 35 million L/yr for the Expanded alternative.

To estimate effluent flows for each alternative, the influent flow was increased by 10 percent to reflect chemical addition and added process water. This increase is based on historical practices, which range from 7 to 9 percent.

Main RLWTF sludge production is simply scaled from the DOE engineering evaluation estimate. One area where influent flow contributions will have operational repercussions is the batch pre-treatment capability in Room 60 of TA-50, Building 1. In this operation, concentrated acid waste streams are neutralized and coprecipitated to reduce TRU constituent levels prior to treatment in the main plant. This operation is expected to produce about 1 m^3/yr of TRU waste at the 20-million-L/yr influent level. This estimate should be increased to ensure that the SWEIS analysis is conservative. For the No Action and Reduced alternatives, pre-treatment levels were estimated to increase by a factor of 2 to 4 times historical values, resulting in a sludge production rate of 2 to 4 m^3/yr. For the Expanded and Greener alternatives, the levels should be increased by a factor of 4 to 8, with sludge volumes ranging from 4 to 8 m^3/yr. These volume totals are distinct from sludge waste associated with the main treatment plant operation, both of which are presented in Table 7-4.

The treated waste water from the RLWTF is discharged to the environment, and therefore the contaminants in the effluent must meet concentration limits specific in the NPDES permit issued by the State of New Mexico. The discharge concentration limits for the radioactive contaminants are presented in Table 7-5.

The discharge limits for non-radioactive constituents are presented in Table 7-6.

7.4. RLW SWEIS Strategies

Treatment of RLW at the main RLWTF at LANL is also the Maximum Onsite strategy for this waste type.

7.4.1. Current Path/Maximum Onsite Strategy

The current path for managing RLW at LANL is identical to the path being pursued to install additional process equipment to meet DCG and nitrate requirements using skid-mounted equipment. Operated as planned under a single-shift schedule, the RLWTF can process about 20 million L/yr. By adding a second shift, the plant can treat up to 40 million L/yr. The overall process flowsheet for this process is presented in Figure 7-2.

For the No Action, Reduced, and Greener alternatives, operation of the RLWTF is expected to generate approximately 75 m^3 of solidified TRU waste and 240 m^3 of dewatered LLW sludge. For the Expanded alternative, operation of the facility is expected to produce approximately 340 m^3 and 110 m^3 of dewatered LLW and solidified TRU sludge, respectively.

7.4.2. Minimum Onsite Strategy

Offsite treatment of RLW was considered as part of the SWEIS strategies analysis, but would be a less practical variation of the onsite treatment strategy. Unlike solid wastes and limited liquid volumes associated with other LANL waste types, RLW is produced in such quantity that offsite treatment of this waste would be both impractical and cost-prohibitive. Technical considerations for hypothetical offsite treatment include conveyance to the offsite location, the treatment facility that would treat the waste, and the effluent limits that would apply to the treated water.

Considering all factors associated with offsite treatment and the current lack of treatment capability for LANL RLW, offsite treatment of RLW is deemed impractical as a waste management strategy for the SWEIS. The discussion below identifies the principal reasons for eliminating this option as a viable RLW management strategy.

7.4.2.1. Conveyance

Conveyance to an offsite location could be accomplished by either batch transport (tanker truck) or pipeline. While a dedicated pipeline would offer a less expensive and more reliable option, no such pipeline exists; one would need to be constructed to the offsite plant. Batch transport would be considerably more expensive than a pipeline, but could be more easily implemented and could convey wastewater to any offsite location. Using the design flow assumption of 20 million L/yr, transport by standard 6500-gallon tanker truck would require about 800 departures a year (1600 round trips). Higher influent flows would require additional departures in direct proportion to the increased flow (for 40 million L/yr, departures would double to 1600.) If the transport distance precluded multiple round trips per day, then several tanker trucks would be required.

Waste water could also be conveyed via pipeline, but the distance over which this option would be viable would be complicated by the number of easements and/or rights-of-way that would be necessary to reach an offsite plant.

7.4.2.2. Treatment Capability

Since no offsite treatment capability exists for LANL RLW flows, implementation of offsite treatment would require the construction of a new treatment plant. The logical model for such a facility would be the revised TA-50 Building 1 plant flowsheet, which has been developed to comply with NPDES requirements for the current outfall. Because there are no other industrial generators with similar waste water to be treated in proximity to LANL, the opportunity to develop or locate a regional treatment capability that could handle similar influents from non-LANL contributors is unlikely. This circumstance suggests that any offsite treatment facility would be very similar to the current onsite RLWTF, except that the facility would be new.

7.4.2.3. Effluent Discharge Limits

One advantage that an offsite treatment facility might be able to offer is a less stringent effluent discharge requirement. The current onsite RLWTF must comply with discharge requirements that are based on drinking water concentration standards because the outfall overlies a series of groundwater systems connected to deeper aquifers that are currently in use. An alternative offsite location might not have this limitation, and could be subject to less stringent discharge requirements.

Offsite treatment could be accomplished by selecting a location that offered direct discharge to a surface water body instead of a groundwater system, or a location where the underlying groundwater system is already unfit for human consumption because of natural constituents. While such a situation is feasible within the regional Southwest, it is not likely within several hundred miles of LANL. Such a waste management strategy is also inconsistent with DOE and LANL compliance objectives, and would not be pursued even if available.

7.5. Strategies Comparison

There is no significant variation between the various management strategies for RLW. The Current Path strategy is analogous to a Maximum Onsite strategy, and a meaningful Minimum Onsite strategy is not available.

Table 7-1. Radioactive constituents and concentrations.

Radionuclide	Concentration (pCi/L)	Radionuclide	Concentration (pCi/L)
Be-7	13,200	Zr-88	4,240
Be-10	.0846	Y-88	5,600
Na-22	1040	Sr-89	517
S-35	439	Sr-90	99
Ti-44	.0846	Zr-95	2,800
Sc-46	1970	Nb-95	2,790
V-48	623	Tc-99	2,320
Cr-51	16,100	Sn-113	.0175
Mn-54	1,810	Cs-137	400
Co-58	2,110	U-234	9,650
Co-60	3,620	U-235	224
Zn-65	9,110	U-238	283
As-74	5,360	Pu-238	40,800
Se-75	9,970	Pu-239	69,700
Sr-85	4,130	Ra-226	.206
Rb-83	12,500	Bi-207	.0846
Rb-84	55,900	Am-241	69,100
Sr-85	11,300		

Table 7-2. Non-radioactive constituents and concentrations.

Constituent	Concentration (mg/L)	Constituent	Concentration (mg/L)
Aluminum	0.63	Potassium	14.6
Ammonia	5.09	Selenium	0.0023
Arsenic	0.0027	Silica	90
Barium	0.102	Silver	0.019
Cadmium	0.0062	Sodium	104
Calcium	23	Sulfate	29.2
Chloride	32	Thallium	0.0023
Chromium	0.071	Uranium	0.18
Chromium	0.15	Vanadium	0.067
Cobalt	0.0062	Zinc	0.40
Copper	0.94	TSS	67.8
Cyanide	0.21	pH	2 to 12
Fluoride	12.7		
Iron	1.61		
Lead	0.29		
Magnesium	3.79		
Manganese	0.0003		
Mercury	0.016		
Nickel	0.19		
Nitrate (NO3)	133		
Nitrate (NO2)	0.19		
Phosphate	4.18		

Table 7-3. Major contributors to the RLWTF.

Generator	L/day	ML/yr
TA-55, nitric acid waste stream	100	.026
TA-55, caustic waste stream	25	.006
TA-55, industrial waste stream	770	0.2
TA-3, CMR Building	41,900	10.9
TA-48, Radiochemistry Laboratory	11,000	3.7
TA-3, Sigma Complex	3,000	0.8
All Others	20,105	4.4
TOTAL	76,900	20.0

Table 7-4. RLW by SWEIS Alternative.

Parameter	No Action	Expanded	Reduced	Greener
Total influent flow	25 million L/yr	35 million L/yr	20 million L/yr	25 million L/yr
Total effluent flow	27.5 million L/yr	38.5 million L/yr	22 million L/yr	27.5 million L/yr
TRU sludge (pretreatment)	2-4 m^3/yr	4-8 m^3/yr	2-4 m^3/yr	4-8 m^3/yr
TRU sludge (main)	20 m^3/yr	26 m^3/yr	15 m^3/yr	20 m^3/yr
LLW sludge (main)	8 m^3/yr	11 m^3/yr	8 m^3/yr	8 m^3/yr

Table 7-5. Discharge limits for non-radioactive constituents.

Constituent	Limit (mg/L)	Constituent	Limit (mg/L)
Aluminum	5	Nickel	0.95
Arsenic	0.002	Ammonia	0.20
Barium	none	Nitrate	10.0
Cadmium	0.05	Selenium	0.63
Chlorine	1.0	Silver	none
Chromium	0.20	Sulfate	600.0
Cobalt	1.0	Vanadium	0.10
Copper	0.50	Zinc	95.4
Cyanide	0.43	pH	6.0 to 9.0
Iron	2.0 lb/day	TDS	1,500
Lead	0.20	TSS	450
Mercury	0.015		

Table 7-6. Discharge limits for radioactive constituents.

Constituent	Effluent Limit (pCi/L)[a]	Constituent	Effluent Limit (pCi/L)[a]
Be-7	1.0E+06	Sr-85	70,000
Na-22	10,000	Sr-90	1,000
V-48	20,000	Y-88	30,000
Mn-54	50,000	Zr-88	100,000
Co-57	200,000	Zr-95	40,000
Co-58	50,000	Nb-95	60,000
Co-60	200,000	Cs-137	1,000
Se-75	50,000	Ra-226	100
As-74	10,000	Pu-238	40
Rb-83	20,000	Pu-239	30
Rb-84	20,000	Am-241	40
		Tritium	2.0E+06

a. DOE Order 5400.5.

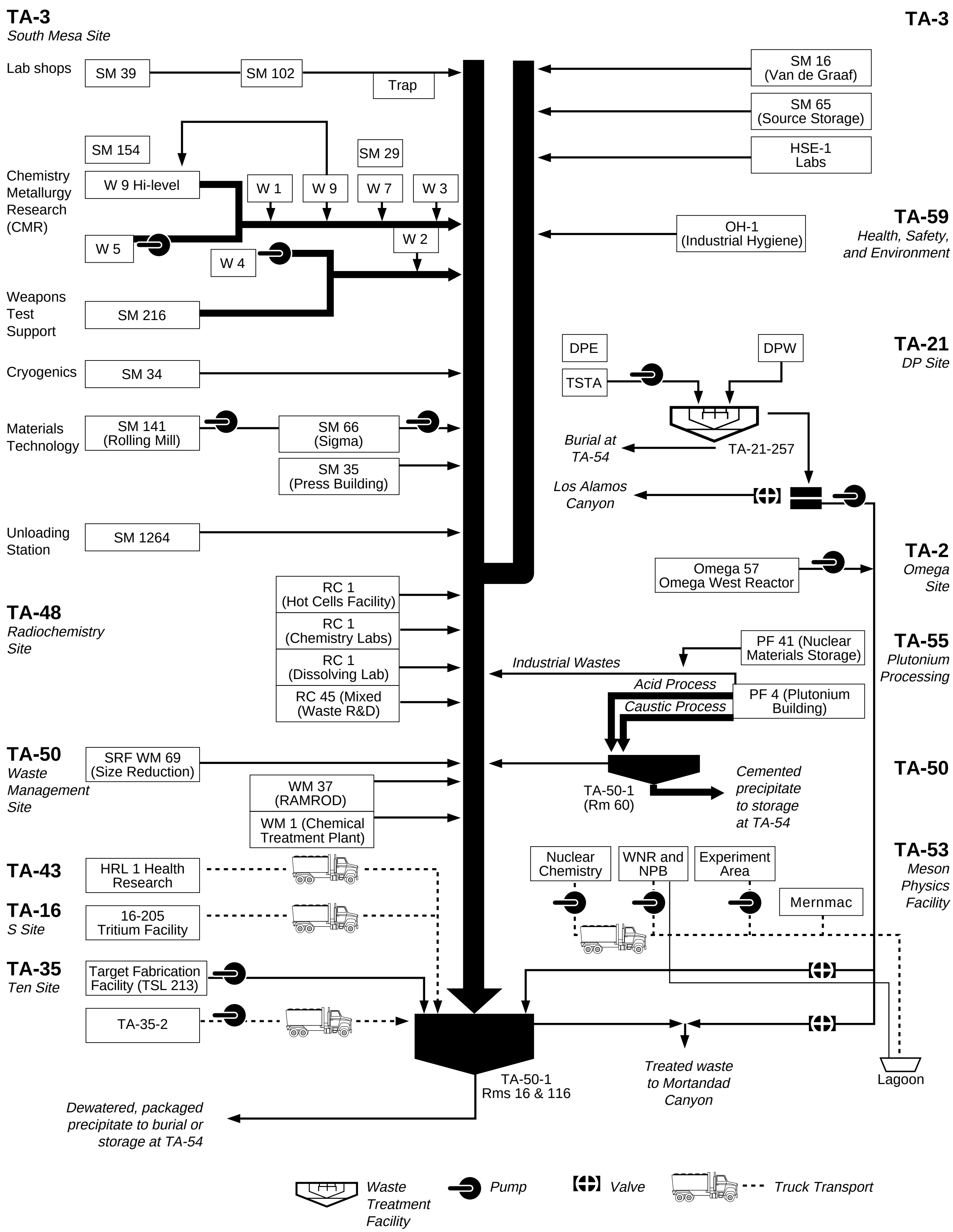

Figure 7-1. Radioactive Liquid Waste Collection System.

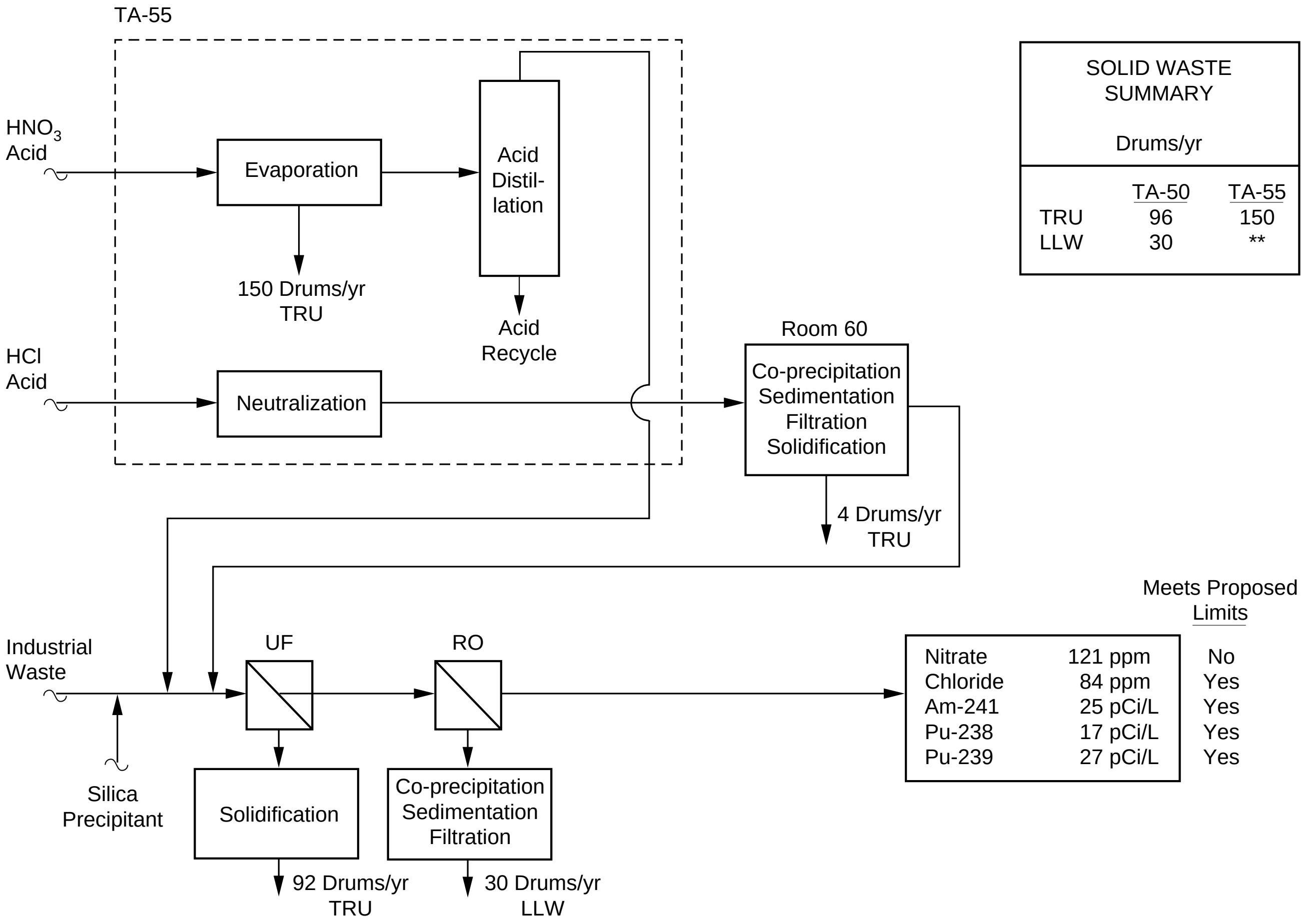

Figure 7-2. Proposed Processing System Configuration.

8. DOE WASTE MANAGEMENT PEIS IMPLICATIONS

This chapter evaluates the implications of using LANL as a regional waste management facility. The WM PEIS estimated the volumes of regulated wastes that LANL would be receiving from other DOE facilities if it were to become a regional waste management facility.

The following PEIS options were selected for evaluation in this report:

Waste Type	PEIS Alternative
LLW	LLW regional alternative 4
TRU	TRU regional alternative 1
MLLW	MLLW regional alternative 2
CHEM	CHEM regional alternative 1
RLW	No PEIS alternative available

The anticipated LLW, TRU waste, MLLW, and chemical waste volumes to be addressed are summarized in Tables 8-1, 8-2, 8-3, and 8-4, respectively. These PEIS waste volumes are combined with the SWEIS Expanded alternative projections to illustrate their effect on waste management facility capacities under the Maximum Onsite strategy. Figures 8-1, 8-2, 8-3, and 8-4 present the waste flow diagrams for LLW, TRU waste, MLLW, and chemical waste strategies, respectively.

Table 8-1. PEIS LLW volumes to be managed at LANL.

Facility	Volume on Hand (m^3)	20-Year Projection (m^3)	10-Year Prorated Volume (m^3)	ER Waste Volume (m^3)	Further Treatment at LANL (m^3)	Direct Disposal at LANL (m^3)
Pantex	34,000	6,100	3,050	0	37,050	0
Sandia National Lab	680	1,800	900	4,171[a] 15,426[b]	5,751	15,426
Kansas City Plant	3	20	10	0	13	0
Grand Junction	0	0	0	0	0	0
Rocky Flats	2,400	39,000	19,500	76,210[c] 113,579[b]	21,900	113,579
				TOTAL	64,714	129,005

a. LLW identified as requiring treatment at LANL.
b. LLW destined for disposal at LANL.
c. LLW being treated at Rocky Flats; inventory already included in the volume destined for disposal at LANL.

Table 8-2. PEIS TRU waste volumes to be managed at LANL.

Facility	Volume on Hand (m^3)	20-Year Projection (m^3)	10-Year Prorated Volume (m^3)	ER Waste Volume (m^3)	Further Treatment at LANL (m^3)	Direct Disposal at LANL (m^3)
Pantex	0	0	0	0	0	0
Sandia National Lab	1	0	0	0	1	0
Kansas City Plant	0	0	0	0	0	0
Grand Junction	0	0	0	0	0	0
Rocky Flats	0	0	0	0	0	0
				TOTAL	1	0

Table 8-3. PEIS MLLW volumes to be managed at LANL.

Facility	Volume on Hand (m^3)	20-Year Projection (m^3)	10-Year Prorated Volume (m^3)	ER Waste Volume (m^3)	Further Treatment at LANL (m^3)	Direct Disposal at LANL (m^3)
Pantex	130	560	280	0	410	0
Sandia National Lab	69	33	16	0	86	0
Kansas City Plant	0	0	0	0	0	0
Grand Junction	0.6	0.9	0.5	0	1	0
Rocky Flats	8,300	13,000	6,500	115,722	0	130,522
				TOTAL:	497	130,522

Table 8-4. PEIS Chemical waste volumes to be managed at LANL.

Facility	Volume on Hand (kg)	20-Year Projection (kg)	10-Year Prorated Volume (kg)	ER Waste Volume (kg)	Further Treatment at LANL (kg)	Direct Disposal at LANL (kg)
Pantex	-	-	-	-	512,000	0
Sandia National Lab	-	-	-	-	153,000	0
Kansas City Plant	-	-	-	-	0	0
Grand Junction	-	-	-	-	0	0
Rocky Flats	-	-	-	-	0	0
				TOTAL	665,000	0

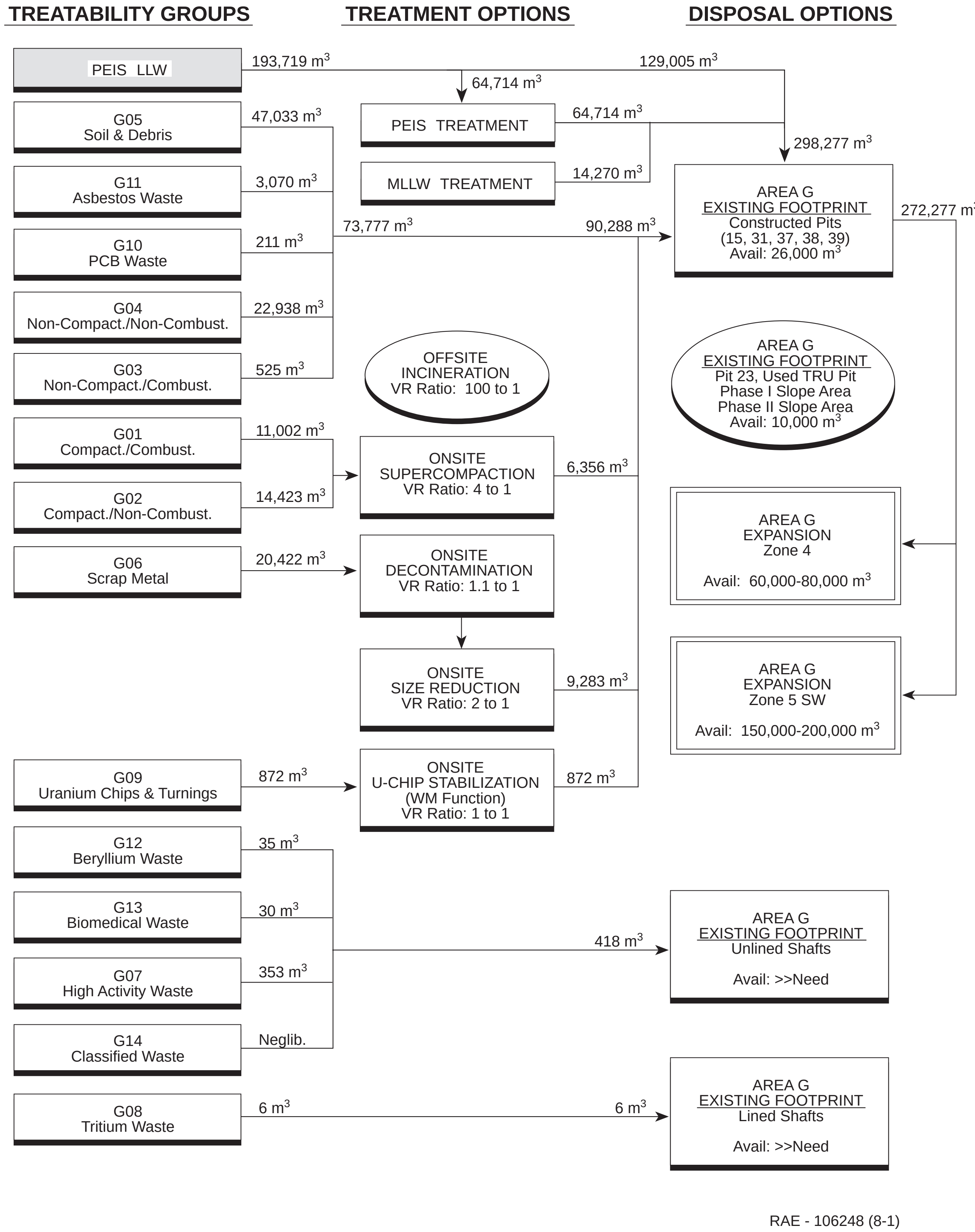

Figure 8-1. Maximum Onsite Strategy for PEIS Expanded LLW Volumes.

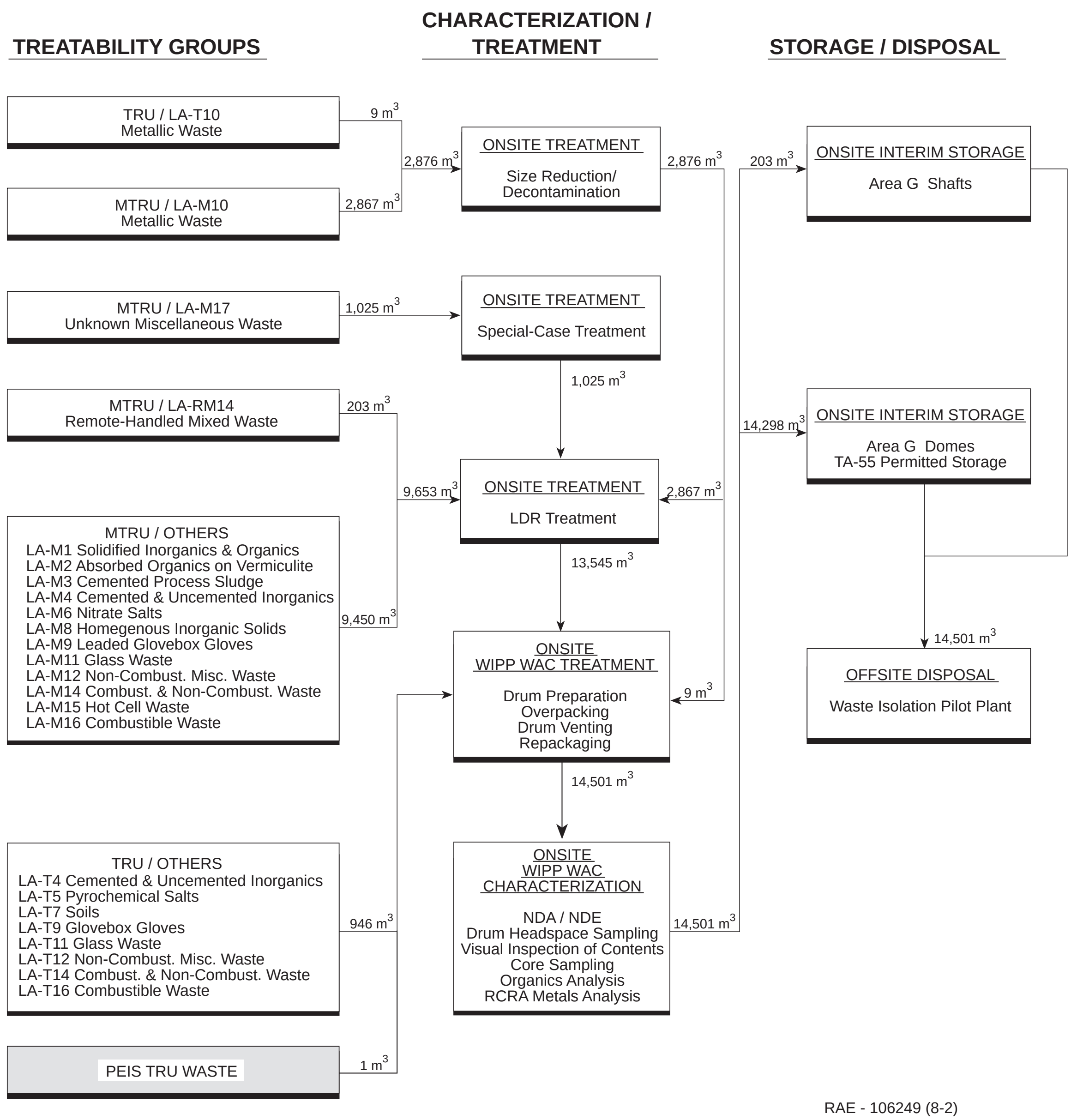

Figure 8-2. Maximum Onsite Strategy for PEIS Expanded TRU Waste Volumes.

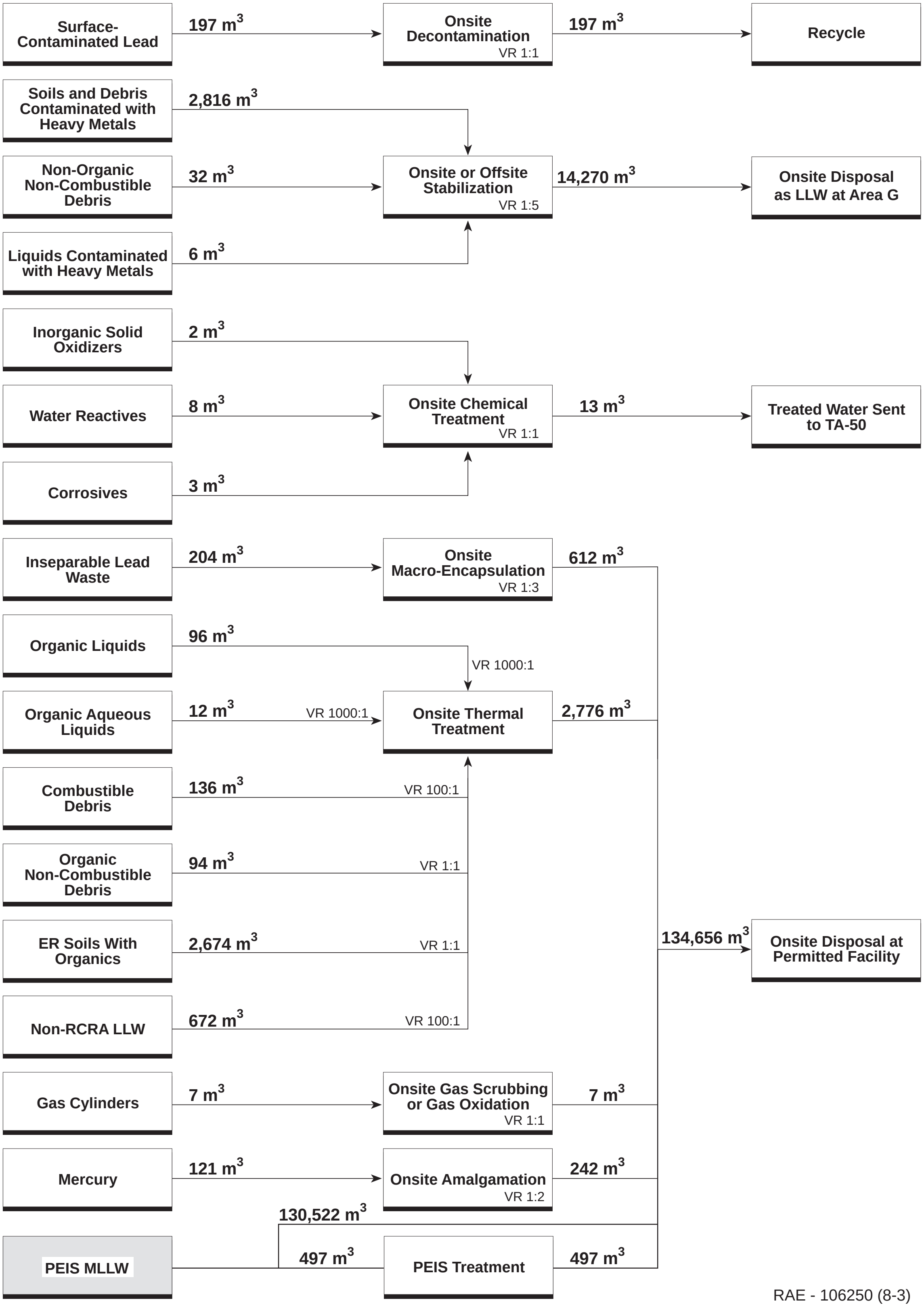

Figure 8-3. Maximum Onsite Strategy for PEIS Expanded MLLW Volumes.

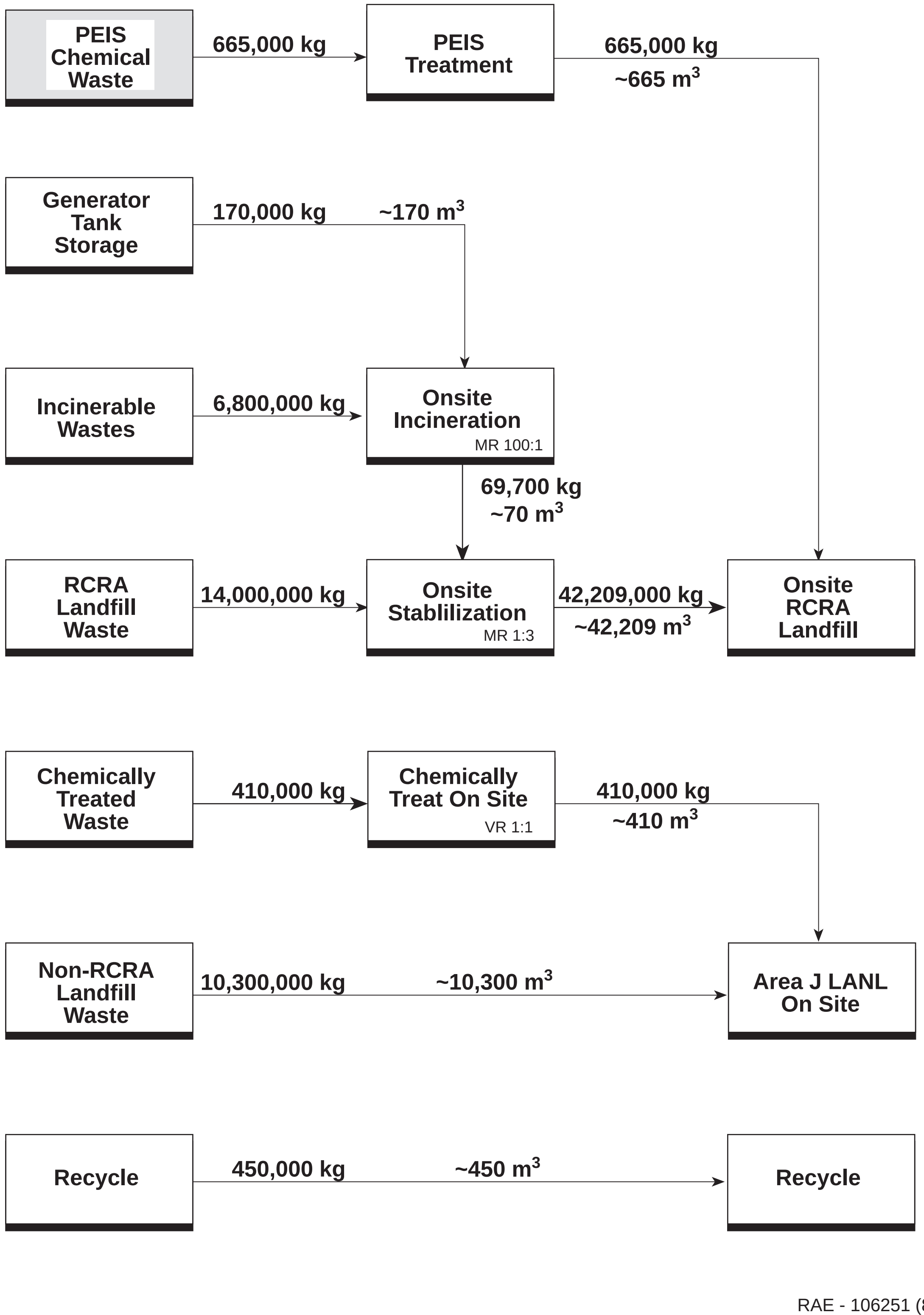

Figure 8-4. Maximum Onsite Strategy for PEIS Expanded Chemical Waste Volumes.

REFERENCES

DOE (US Department of Energy), September 26, 1988. “Radioactive Waste Management,” DOE Order 5820.2A, Washington, DC.

DOE (US Department of Energy), June 5, 1990. "Radiation Protection of the Public and the Environment," DOE Order 5400.5 (Change 1), Washington, DC.

DOE (US Department of Energy), August 1995. “Draft Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste,” Volume 1, DOE-EIS-0200- D, Washington, DC.

DOE (US Department of Energy), April 1996. “Waste Acceptance Criteria for the Waste Isolation Pilot Plant,” DOE/WIPP-069, Revision 5, Carlsbad, New Mexico.

LANL (Los Alamos National Laboratory), December 1, 1994. “CST Waste Management Facilities Waste Acceptance Criteria and Certification,” Los Alamos National Laboratory Plan WASTE-MGMT-PLAN-002, R0, Los Alamos, New Mexico.

LANL (Los Alamos National Laboratory), August 8 1996. “LANL TRU Waste Management Plan” (Draft), Los Alamos, New Mexico.

Merrick & Company, University of California, Los Alamos National Laboratory, December 18, 1995. “Conceptual Design Report, Radioactive Liquid Waste Treatment Facility at the Los Alamos National Laboratory, Project Identification No. 10411,” Los Alamos, New Mexico.

New Mexico Environment Department, October 4, 1995. “Federal Facility Compliance Order and Site Treatment Plan,” Santa Fe, New Mexico.

Rogers & Associates Engineering Corporation, September 30, 1996. “SWEIS Waste Projections Data Package,” C9148/641, Salt Lake City, Utah.

Vance, J., Vance & Associates, Inc.; T. Monaghan, D. Finfrock, M. Byrd, and E. Johnson, Roy F. Weston, Inc.; J. Shipp and J. Bowen, Stone & Webster Engineering Corp.; and M. A. Olascoaga, Barnwell Engineering, Inc., July 1996. “An Evaluation of Options for Implementing New Radioactive Liquid Waste Treatment Processes at Los Alamos National Laboratory,” prepared for Los Alamos National Laboratory’s Waste Management Program Office and the US Department of Energy’s Albuquerque Operations Office Waste Management Division.

ACRONYMS AND ABBREVIATIONS

ALARA	As low as reasonably achievable
AK	Acceptable knowledge
BIR_WS	Baseline Inventory Report Waste Stream
CAI	Controlled-Air Incinerator
CCO	Catalytic chemical oxidation
CD	Compact disk
CMIP	Capability Maintenance and Improvement Project
CMR	Chemistry and Metallurgy Research (Building)
CRADA	Cooperative research and development agreement
CST	Chemical Science and Technology (Division)
CTSD	Characterization, treatment, storage, and disposal
D&D	Decontamination and decontamination
DC	Direct current
DCG	Derived concentration guide
DOE	Department of Energy
DOT	Department of Transportation
DPF	Drum Preparation Facility
DVS	Drum-Venting System
EIS	Environmental impact statement
EPA	Environmental Protection Agency
ER	Environmental restoration
HEPA	High-efficiency particulate air (filter)
LANL	Los Alamos National Laboratory
LDR	Land disposal restriction
LTTD	Low-temperature thermal desorption
LLW	Low-level waste
MLLW	Mixed low-level waste
MTRU	Mixed transuranic waste
MWDF	Mixed-Waste Disposal Facility
NEPA	National Environmental Policy Act
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NTP	Nonthermal plasma
NTS	Nevada Test Site
PAN	Mobile Passive/Active Neutron Interrogation System
PCB	Polychlorinated biphenyl
PHP	Plasma hearth process
PEIS	Programmatic environmental impact statement
RCRA	Resource Conservation and Recovery Act
RLW	Radioactive liquid waste
RLWTF	Radioactive Liquid Waste Treatment Facility
SGS	Segmented gamma spectrometry

SVOC	Semivolatile organic compound
SWB	Standard waste box
SWEIS	Site-wide environmental impact statement
TRU	Transuranic waste
TSCA	Toxic Substances Control Act
TSD	Treatment, storage, and disposal
TWISP	TRU Waste Inspectable Storage Program
WAC	Waste acceptance criteria
WCRRF	Waste Characterization, Reduction, and Repackaging Facility
WERF	Waste Experimental Reduction Facility
WIPP	Waste Isolation Pilot Plant
WM PEIS	Waste Management Programmatic Environmental Impact Statement
VOC	Volatile organic compound
VR	Volume reduction